

Feature-Based Machining

What's New

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future deliverables in this document

Tom van 't Erve
Director NX CAM Development

June 2008

Feature-based Machining

What does it include



Machining Feature identification

- Re-use from CAD, Recognition, Tagging, ...

Manufacturing Process Planning

- Suggest the best set of operations for a feature
- Suggest the best cutting tool for each operation
- Suggest the best process conditions for each operation
- Calculate the operation cycle time
- Group the operations into setups
- Optimized operation sequence

NC Programming

- Generate the tool path for each operation
- Create and validate NC programs

Feature-based Machining

Why should you be interested



Process Automation

- Significantly reduce the time needed to create NC programs
- Productivity improvements of 10x have been documented

Process Quality

- Reduce the amount of mistakes in “simple” and “repetitive” NC programming tasks
- Spend more time on critical / non-standard tasks

Process Standardization

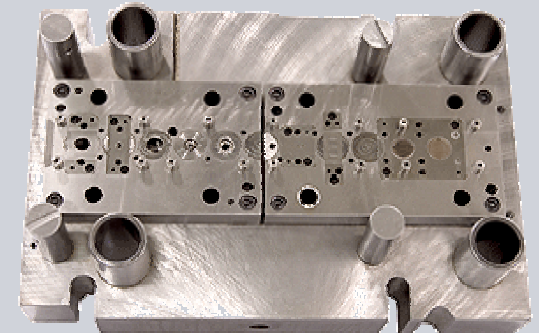
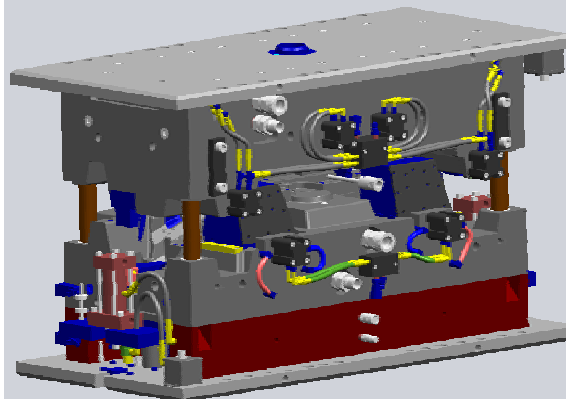
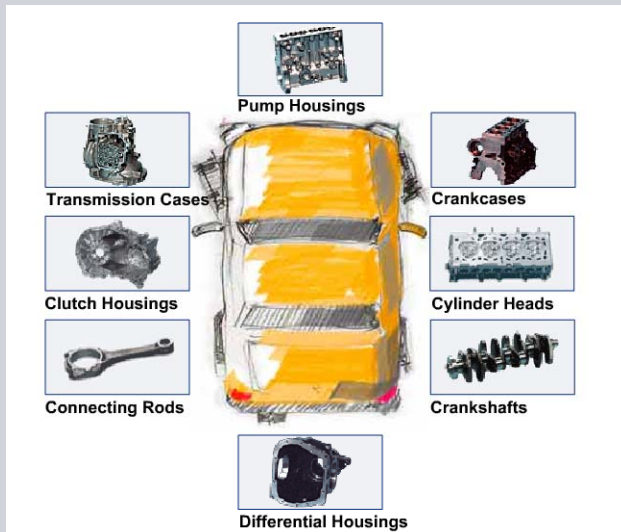
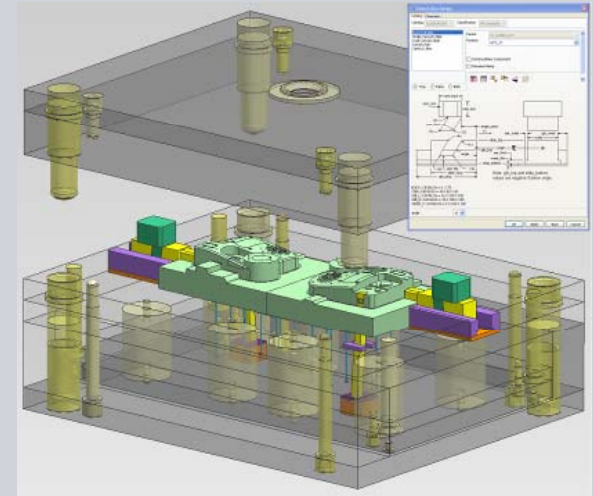
- Ensure that the “standard process” is used by default
- Support the standardization of cutting tools

Feature-based Machining

Where can it be applied today?

2½D Prismatic Machining

- Standard features appear in many different parts like
 - Mold bases
 - Machinery parts
- Predominantly holes, pockets and slots



NX 6 Plans

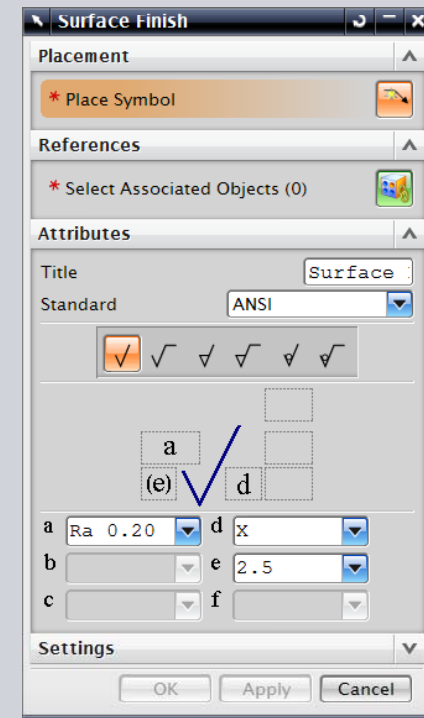
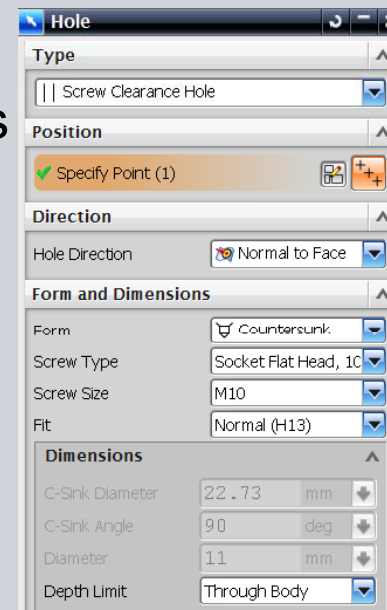
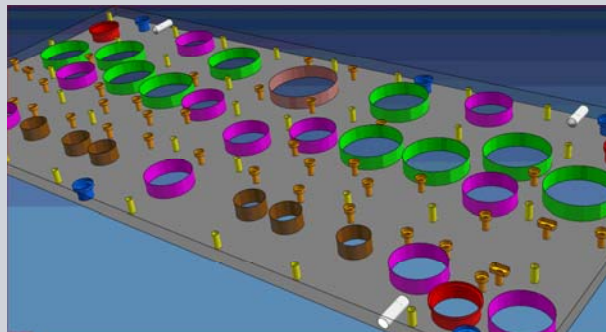
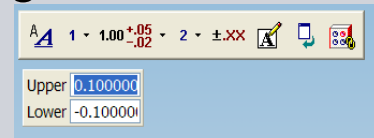
Make it work for the majority of the NX CAM users without having to go through a long and costly customization project first

- Increase Feature Recognition scope and robustness (milling features, intersections/interruptions, compounds, PMI, ...)
- Provide out-of-the-box solution without the need for extensive customer specific implementation
- Simplify the customization process (both for the features and the operation selection rules)

Machining Features

Feature-based Machining NX 6 Machining Feature Recognition Projects

1. Add the *Machining Line Planner™ (MLP)* Feature Recognition technology to NX CAM
2. Enhance the Recognition with OOTB support for **PMI**
 - Upper and lower dimension tolerances, Fits and Limits
 - Thread and thread tolerances
 - Surface finish
 - Face attributes & colors
3. Support for new NX 6 AHF features
4. Configurable Feature Mapping



Machining Feature Recognition Projects

1.1 Offers additional 2½D milling Feature Types



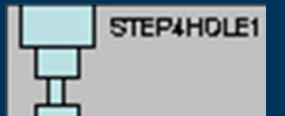
MLP – Feature Recognition component

Stepped Hole/Pocket features

TECNOMATIX

1. Top_chamfer
2. Top_chamfer_1
3. Cylinder_1
4. Bottom_chamfer_1
5. Bottom_1
6. Top_chamfer_2
7. Cylinder_2
8. Bottom_chamfer_2
9. Bottom_chamfer

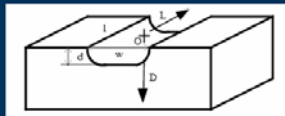
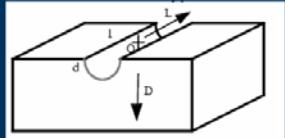
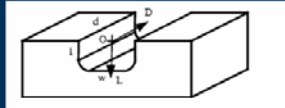
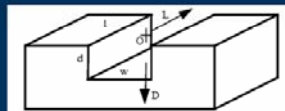
STP



MLP – Feature Recognition component

Example Slot Feature types

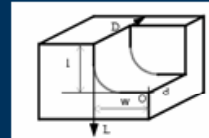
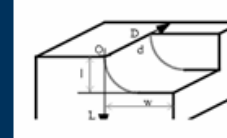
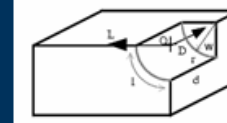
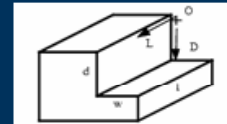
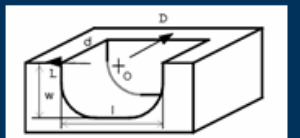
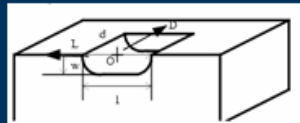
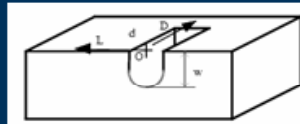
TECNOMATIX



Machining Line Planner

Partial Slot & Corner Notch Features



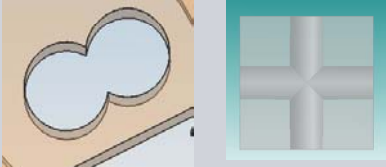

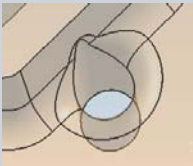

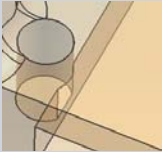

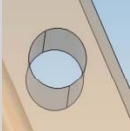

TECNOMATIX



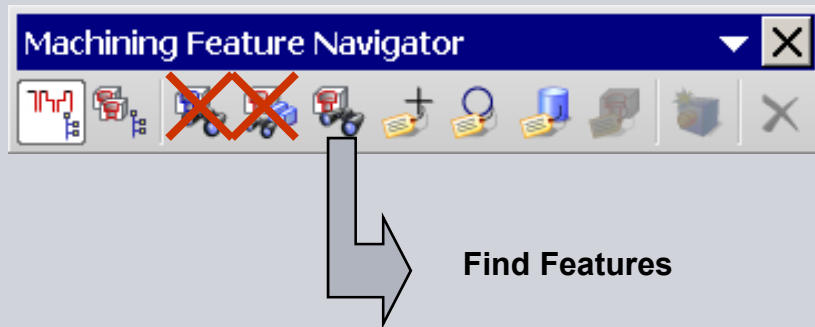
Proven functionality (> 10 years of industry experience)
Large number of extra OOTB 2½D milling features

Machining Feature Recognition Projects

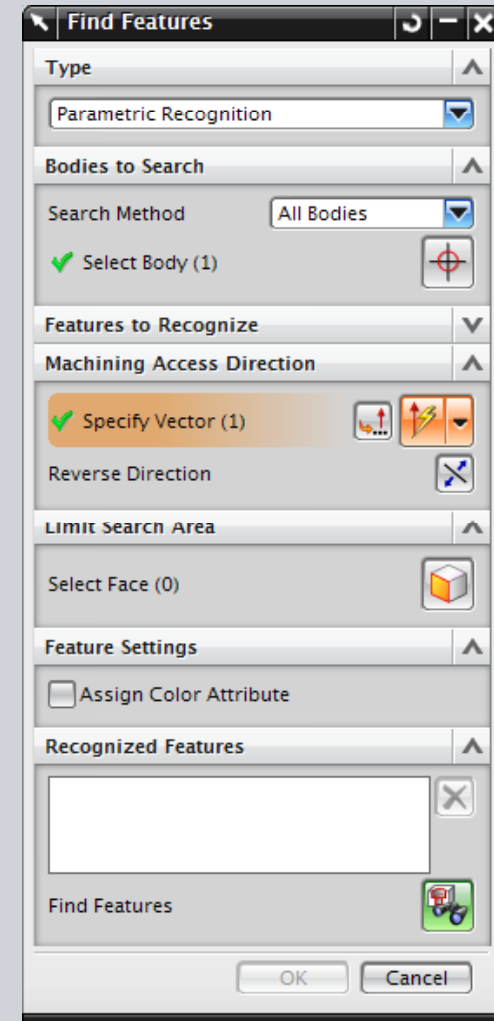
1.2 More Robust Recognition

Issue	Description	MLP component
	Open features	
	Intersecting features	
	Blended features	
	Partially intersecting features	
	Split faces (non NX geometry)	

Machining Feature Recognition Projects NX 6 User Interface and Functionality

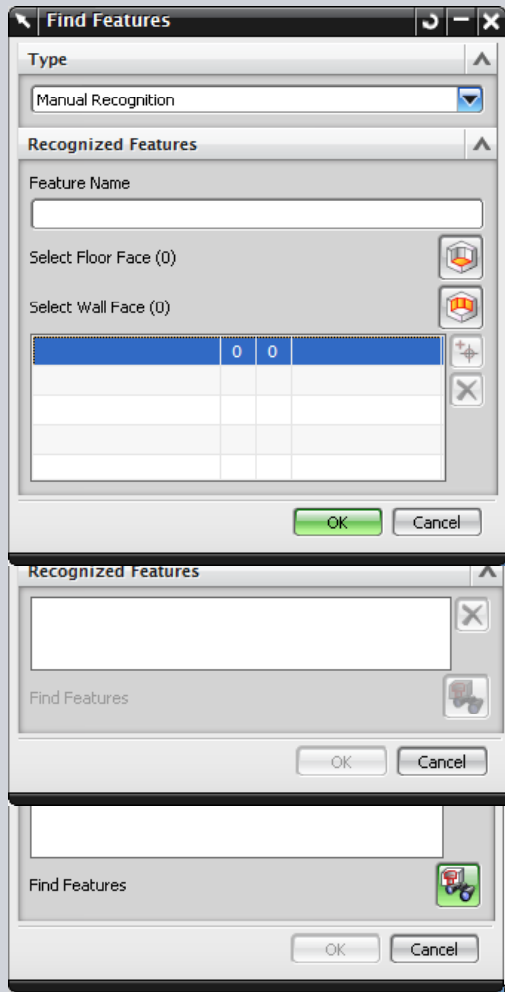


- Replaced NX5 Identification & Recognition commands with a single ***Find Features*** command
- All identification and recognition modes are now available from within the ***Find Features*** dialog
- Block based UI that adjusts to the “Type” of Recognition / Identification



Machining Feature Recognition Projects

NX 6 User Interface and Functionality



Five ways to Find Feature:

- ▶ CAD Feature Identification
- ▶ Parametric (new) Feature Recognition
- ▶ Legacy Hole Recognition
- ▶ Legacy Face & Pocket Recognition
- ▶ Manual Feature Definition

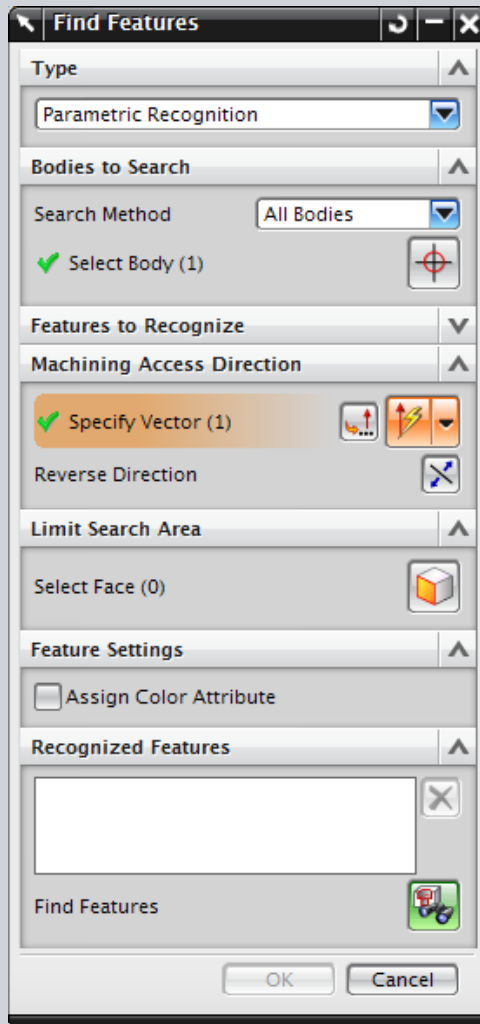
Additional enhancements:

- ▶ No double recognition
- ▶ Sheet and Solid body support
- ▶ Persistent feature type selection

Configurable Feature Mapping available for all Identification and Recognition methods

Machining Feature Recognition Projects

NX 6 User Interface and Functionality



New standard capabilities:

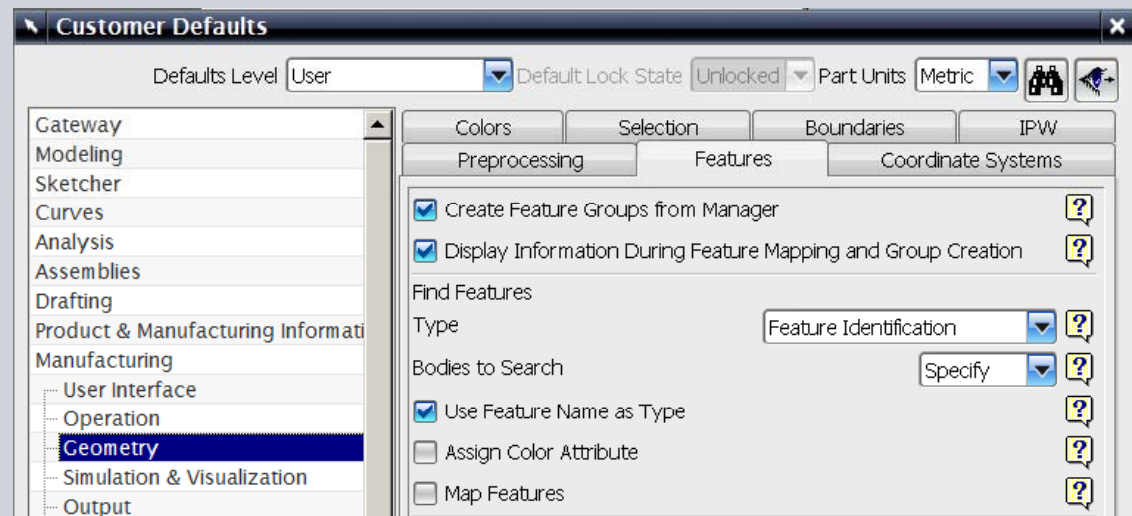
- ▶ Bodies to Search
 - ▶ Workpiece
 - ▶ All Bodies
 - ▶ Specify
- ▶ Machining Access Direction
 - ▶ Find only features from a specific direction
- ▶ Limit Search Area
 - ▶ Find only features that contain any of the selected faces
- ▶ Feature Settings
 - ▶ Assign Color Attribute

Customer Defaults are available to configure the preferred default behavior

Machining Feature Recognition Projects

NX 6 User Interface and Functionality

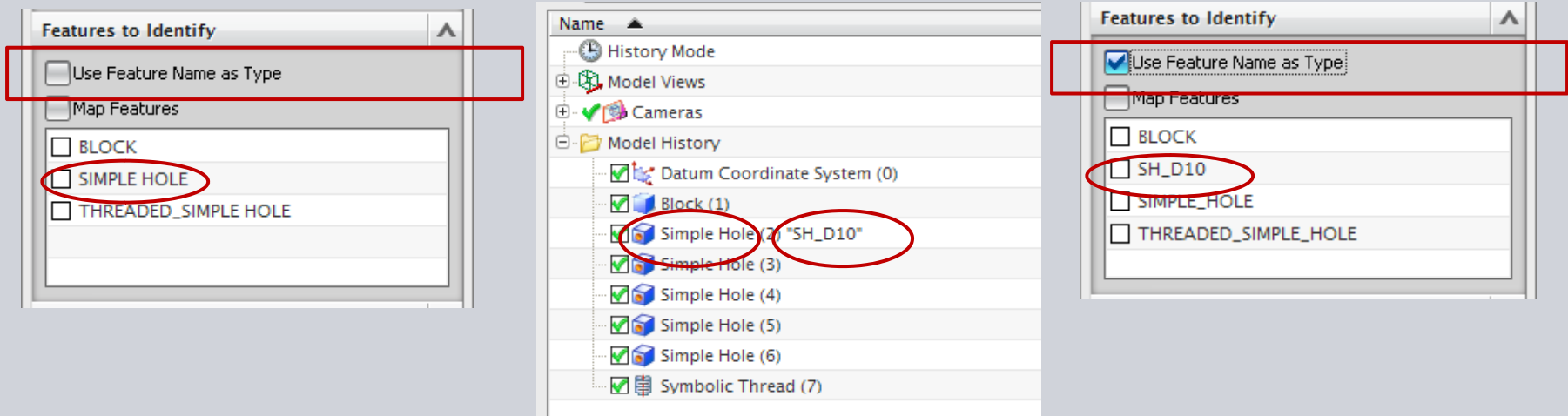
- Use Customer Defaults to pre-set UI defaults
 - Find Features (Type)
 - Bodies to Search
 - Use Feature Name as Type
 - Assign Color Attribute
 - Map Features



Machining Feature Recognition Projects NX 6 User Interface and Functionality

Feature Settings for Feature Identification:

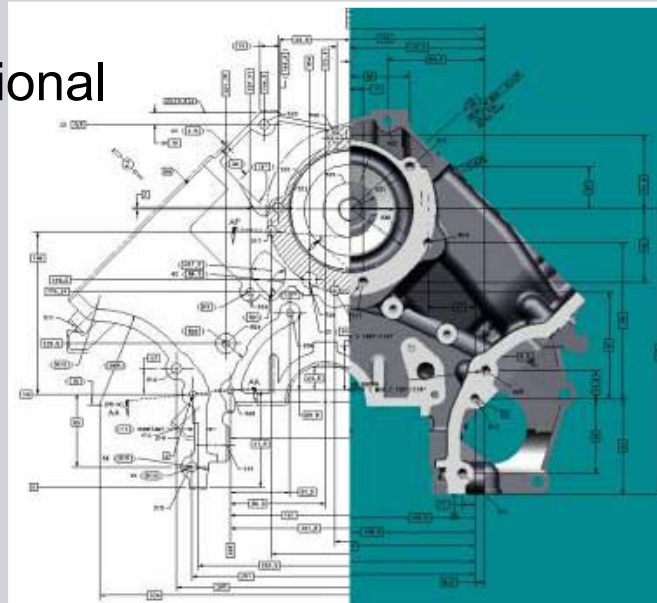
- Use Feature Name as Type
 - Optionally identify and create machining features by either their design type or name (if i.e. renamed)



What is PMI?

Product and Manufacturing Information

- Any associated annotation that can be placed in 3D space with the model, or directly on the model.
- PMI is supported by national and international standards



Directions

- Capture and communicate design intent in the context of a single 3D “master” definition
- Facilitate downstream reuse of design information
- Automated documentation tools
- Automatic Standards conformance for all annotation
- Reduce or eliminate redundant, tedious effort required for 2D drawing creation

NX PMI Basic Functionality Overview

Product and Manufacturing Information (PMI) Directly on 3D Model

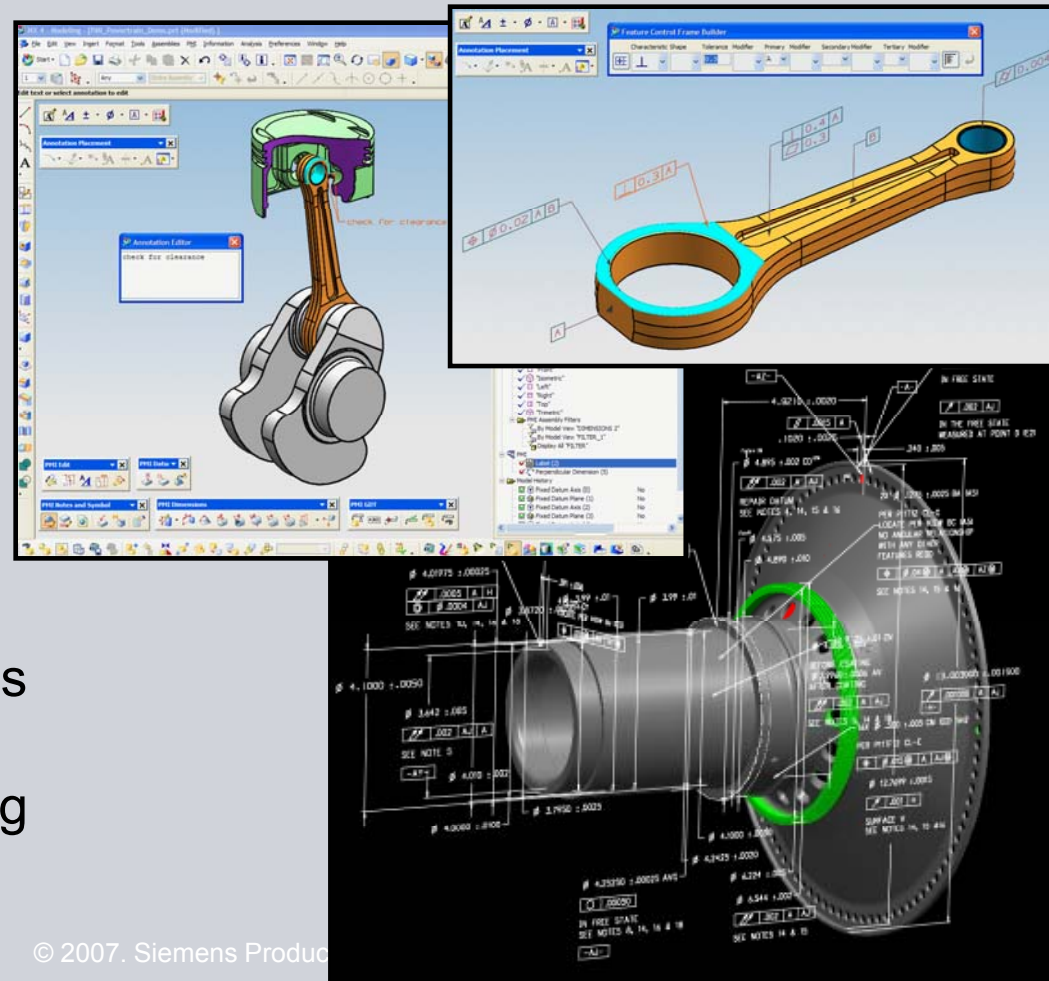
- Dimensions w/Tolerances
- Datums and Targets
- Feature Control Frames
- Associative Notes / URL

Model Views

- PMI Created in Each View
- Filters Control Visibility
- 3D Section Views
- Query Associated Objects

PMI on Parts and/or Assemblies

Transfers Directly to 2D Drafting

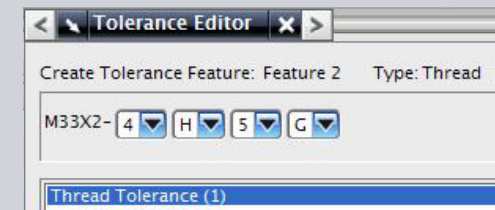
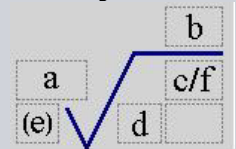


© 2007, Siemens Product

PMI flow down to CAM

How does PMI impact Machining?

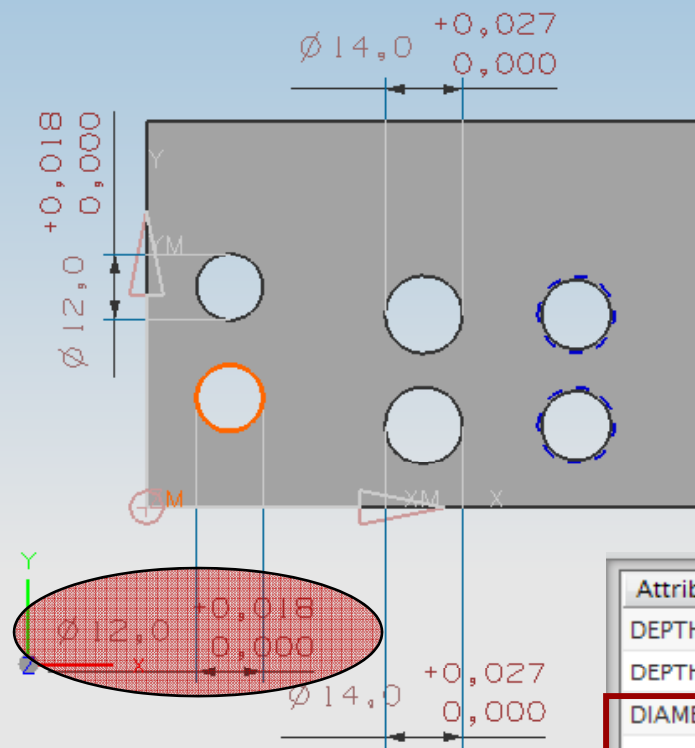
1. Select the right manufacturing / machining process
 - NC Machining (Milling, Drilling), Honing, Grinding, Heat treatment, ...
2. Define the appropriate setup datum scheme and/or perform key operations in the same setups
 - Form tolerances (perpendicularity, parallelism, flatness, concentricity, etc.)
3. **Select the right processes & resources per machining feature**
 - **Dimension tolerance (± 0.01)**
 - **Fits and limits (e.g. H7)**
 - **Surface finish value**
 - **Thread information (type, pitch, thread length, ...)**
 - **User defined attributes and colors**
4. Machine individual operations at the correct location using the right dimensions
 - Mid tolerance machining on non-symmetrical position & dimension tolerances
 - Minimum / Maximum material conditions



Machining Feature Recognition Projects

Recognizing PMI data

Dimension Tolerance Recognition



Value	Tolerance	Text	References	Settings
1.00 ^{+0.05} _{-.00}	1	±.XX 3		A

Attribute ▲	Value	Overridden	Original Value	
DEPTH_TOP_CHAMFER_1	0.000000000		0.000000000	▲
DEPTH_UPPER	0.200000000		0.200000000	
DIAMETER_1	12.000000000		12.000000000	
DIAMETER_1_LOWER	0.000000000		0.000000000	
DIAMETER_1_UPPER	0.018000000		0.018000000	
RADIUS_BOTTOM_CHAMFER	0.000000000		0.000000000	
RADIUS_BOTTOM_CHAMFER_1	0.000000000		0.000000000	
RADIUS_TOP_CHAMFER	0.000000000		0.000000000	▼

Machining Feature Recognition Projects

Recognizing PMI data

Checked Limits & Fits Tolerances

Edit Tolerance Feature: #Feature 1 Type: Hole

Deviation: F G H Grade: 5 6 7 Limit Values: (#0.015 0.000) × 10H7

Limits and Fits Tolerance (47)

± H7/96 4H ↓ 0.015 0.000 Millimeters

Appended Text Zone Refinements Keywords Profile Options

Below ↓

OK Apply Back Cancel

Attribute ▲	Value	Overridden	Original Value
DEPTH_LOWER	-0.200000000		-0.200000000
DEPTH_TOP_CHAMFER	0.000000000		0.000000000
DEPTH_TOP_CHAMFER_1	0.000000000		0.000000000
DEPTH_UPPER	0.200000000		0.200000000
DIAMETER_1	10.000000000		10.000000000
DIAMETER_1_LOWER	0.000000000		0.000000000
DIAMETER_1_UPPER	0.015000000		0.015000000
RADIUS_BOTTOM_CHAMFER	0.000000000		0.000000000

Name (Instance Filter: All)

ug_pmi_test

Tolerance Features

Feature 1

± 0.015 0.000

Type: Pin/Hole

Operation: Feature of Size

Advanced Selection Description

Pattern

Selection Steps

Tolerances and Instances

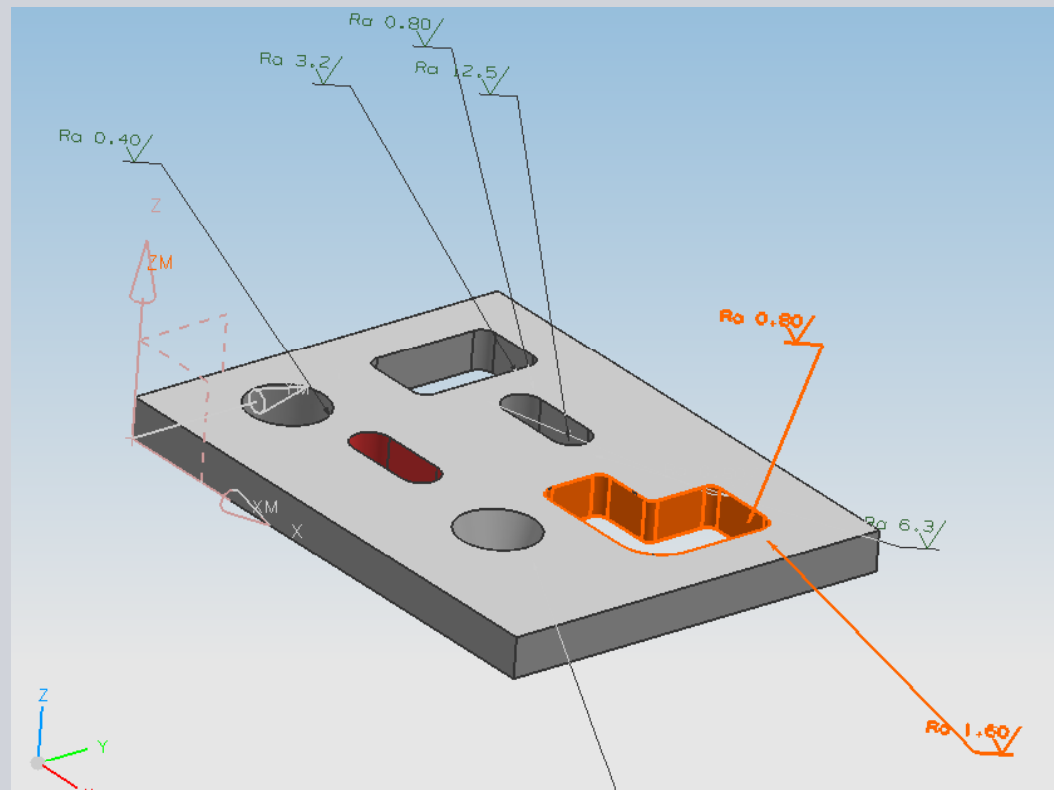
OK Apply Cancel

Machining Feature Recognition Projects

Recognizing PMI data

Surface Finish Recognition

SIEMENS



SIDE_ROUGHNESS	RA 0.80
SIDE_ROUGHNESS_ALLOWANCE	
SIDE_ROUGHNESS_DIRECTION_OF_LAY	
SIDE_ROUGHNESS_MATERIAL_REMOVAL	UNSPECIFIED
SIDE_ROUGHNESS_MODIFIER	NONMODIFIER
SIDE_ROUGHNESS_PROCESS	
SIDE_ROUGHNESS_ROUGHNESS_CUTOFF	

Surface Finish

Origin

✓ Specify Location

Alignment

Orientation

Leader

Associated Objects

Attributes

Title: Surface Finish

Standard: ANSI

✓ ✓ ✓ ✓ ✓ ✓

a ✓ d

(e)

Upper Text (a): Ra 0.80

Waviness (b):

Cutoff 1 (c):

Lay Symbol (d):

Machining (e):

Cutoff 2 (f):

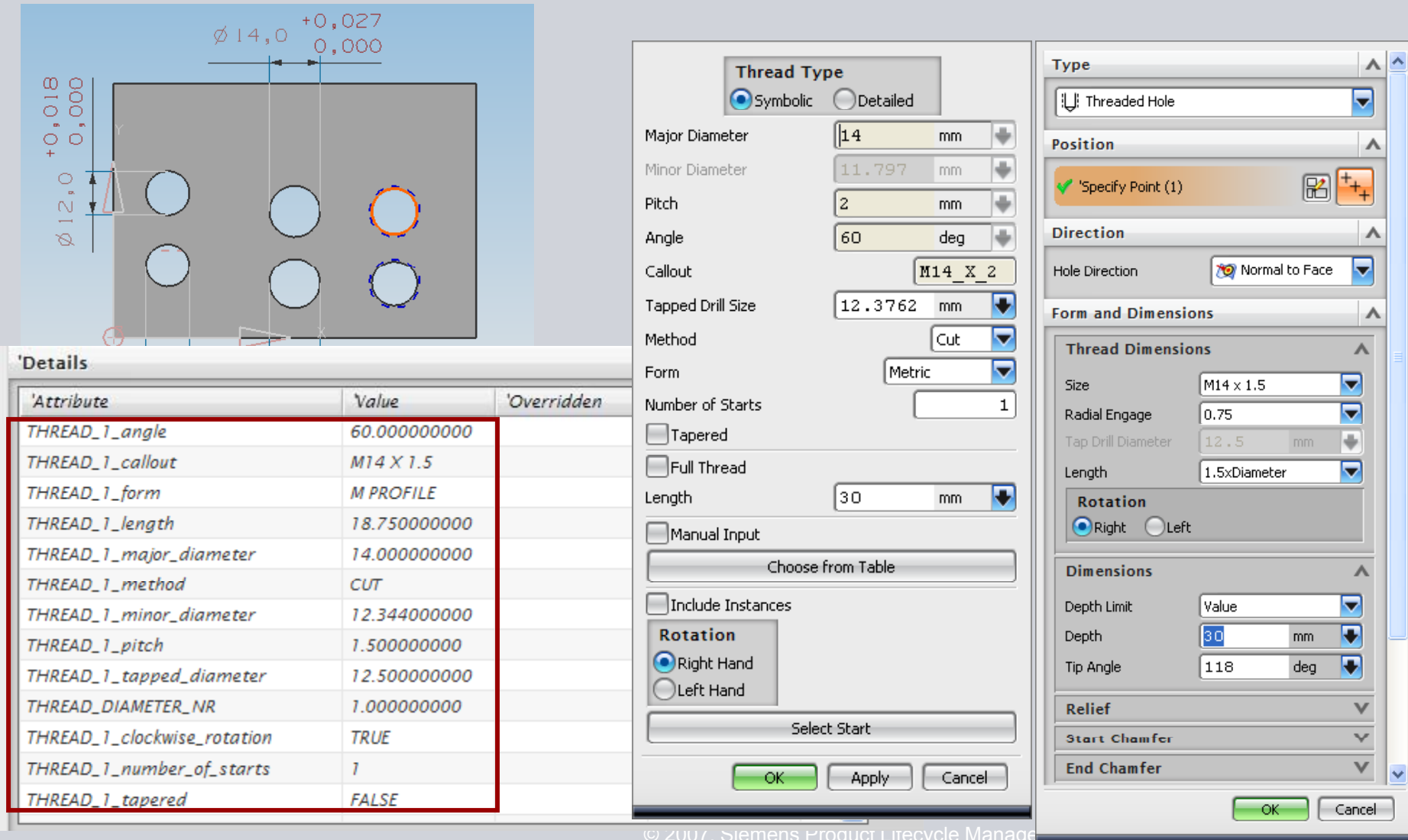
Settings

OK Apply Cancel

Machining Feature Recognition Projects

Recognizing PMI data

Thread Recognition



Technical Drawing: A plate with six holes. The top hole is highlighted with a thread. Dimensions shown: $\varnothing 14,0$ with a tolerance of $+0,027$ to $0,000$. The hole diameter is $\varnothing 12,0$ with a tolerance of $+0,018$ to $0,000$.

'Details' Table:

'Attribute'	'Value'	'Overridden'
THREAD_1_angle	60.00000000	
THREAD_1_callout	M14 X 1.5	
THREAD_1_form	M PROFILE	
THREAD_1_length	18.75000000	
THREAD_1_major_diameter	14.00000000	
THREAD_1_method	CUT	
THREAD_1_minor_diameter	12.34400000	
THREAD_1_pitch	1.50000000	
THREAD_1_tapped_diameter	12.50000000	
THREAD_DIAMETER_NR	1.00000000	
THREAD_1_clockwise_rotation	TRUE	
THREAD_1_number_of_starts	1	
THREAD_1_tapered	FALSE	

Thread Type Configuration:

- Type: Symbolic
- Major Diameter: 14 mm
- Minor Diameter: 11.797 mm
- Pitch: 2 mm
- Angle: 60 deg
- Callout: M14_X_2
- Tapped Drill Size: 12.3762 mm
- Method: Cut
- Form: Metric
- Number of Starts: 1
- Tapered: ☐
- Full Thread: ☐
- Length: 30 mm
- Manual Input: ☐
- Choose from Table:
- Include Instances: ☐
- Rotation: Right Hand
- Select Start:

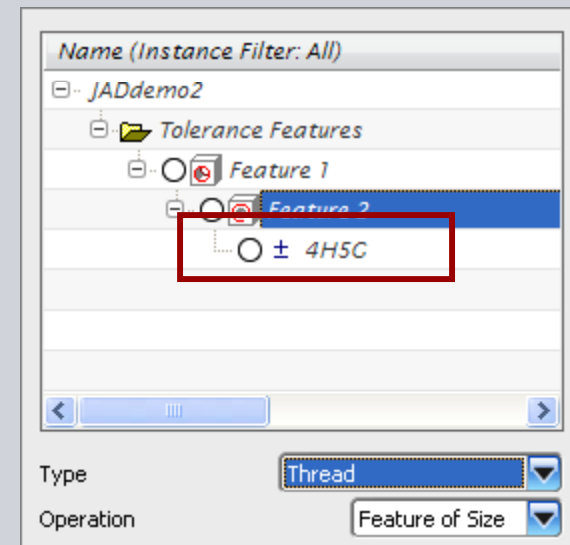
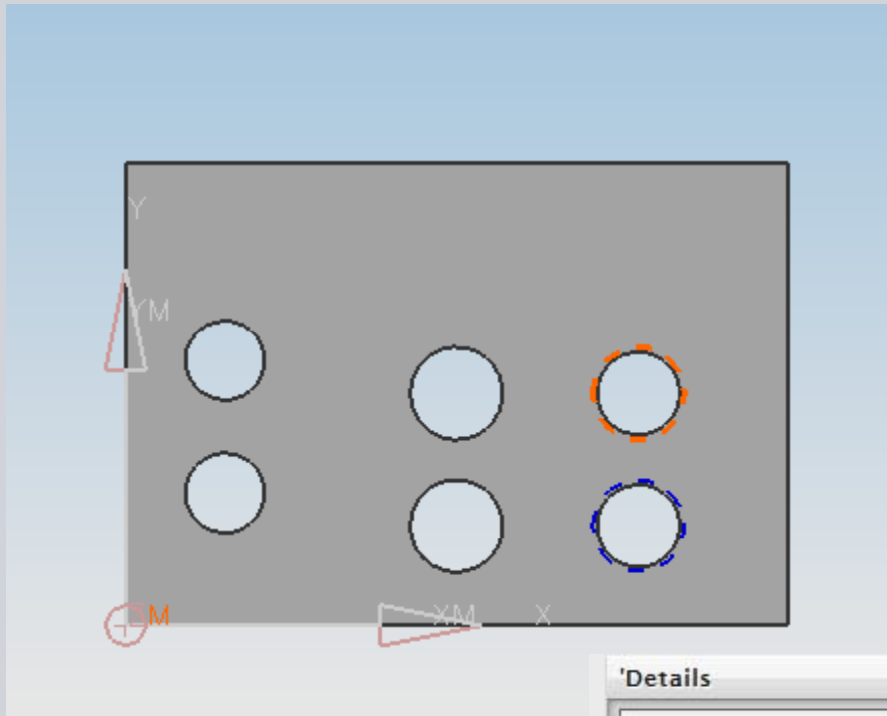
Thread Dimensions Configuration:

- Type: Threaded Hole
- Position: Specify Point (1)
- Direction: Normal to Face
- Form and Dimensions:
 - Thread Dimensions:
 - Size: M14 x 1.5
 - Radial Engage: 0.75
 - Tap Drill Diameter: 12.5 mm
 - Length: 1.5x Diameter
 - Rotation: Right
 - Dimensions:
 - Depth Limit: Value
 - Depth: 30 mm
 - Tip Angle: 118 deg
 - Relief:
 - Start Chamfer:
 - End Chamfer:

Machining Feature Recognition Projects

Recognizing PMI data

Thread Tolerance Recognition



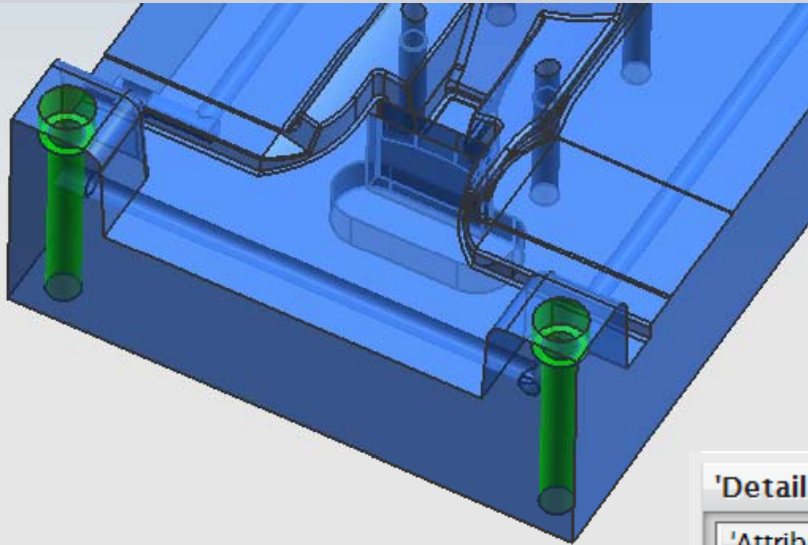
'Details'			
'Attribute'	'Value'	'Overridden'	'Original Value'
THREAD_1_clockwise_rotation	TRUE		TRUE
THREAD_1_number_of_starts	1		1
THREAD_1_tapered	FALSE		FALSE
THREAD_METRIC_M_DIA_DEVIATION	C		C
THREAD_METRIC_M_DIA_GRADE	5.000000000		5.000000000
THREAD_METRIC_PITCH_DIA_DEVIATION	H		H
THREAD_METRIC_PITCH_DIA_GRADE	4.000000000		4.000000000

Machining Feature Recognition Projects
















Recognizing PMI data

Feature Attribute and Color Recognition

SIEMENS



Selected Color

Machining Feature Identification Projects

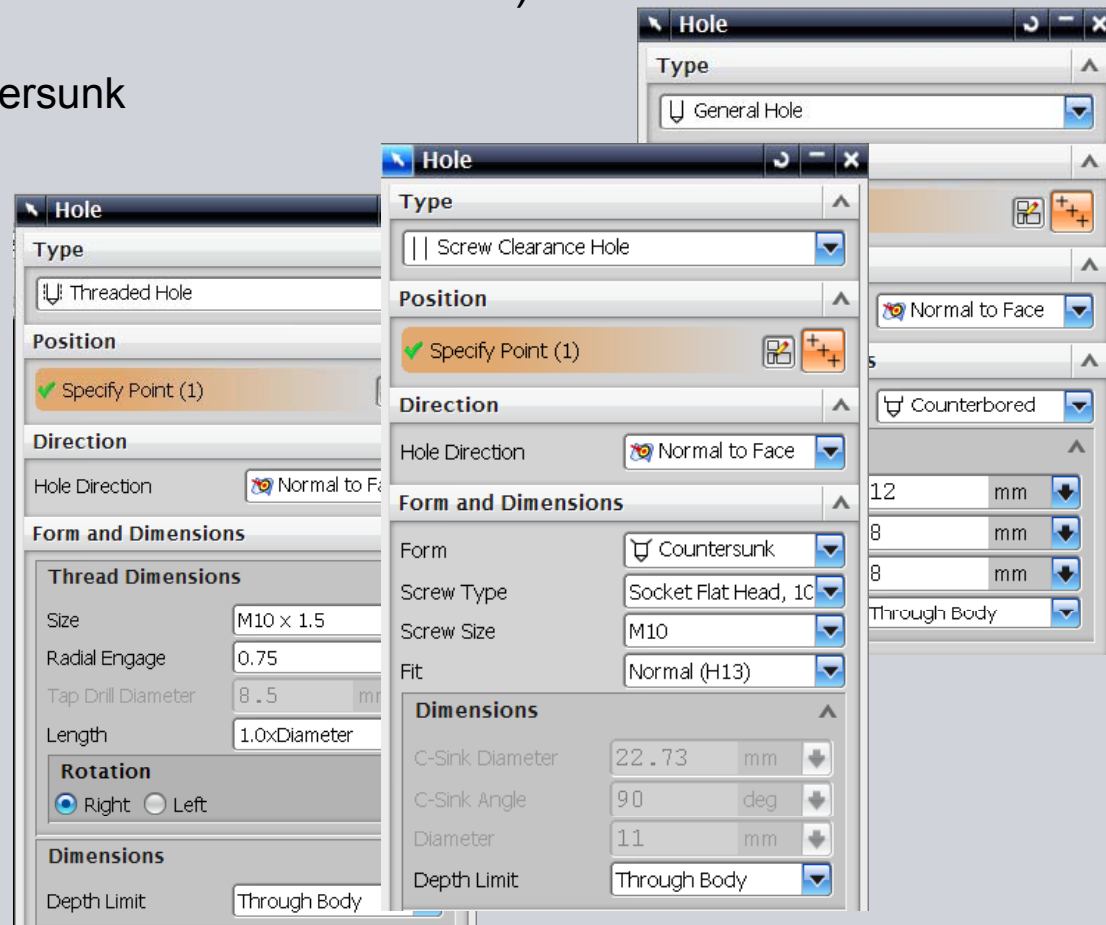
New NX AHF hole feature support

What is it?

- New NX hole features (preview available with NX5.0.2)
 - General Hole
 - Simple, Counterbored, Countersunk
 - Screw Clearance Holes
 - Threaded Holes
 - Hole Series (as individuals)

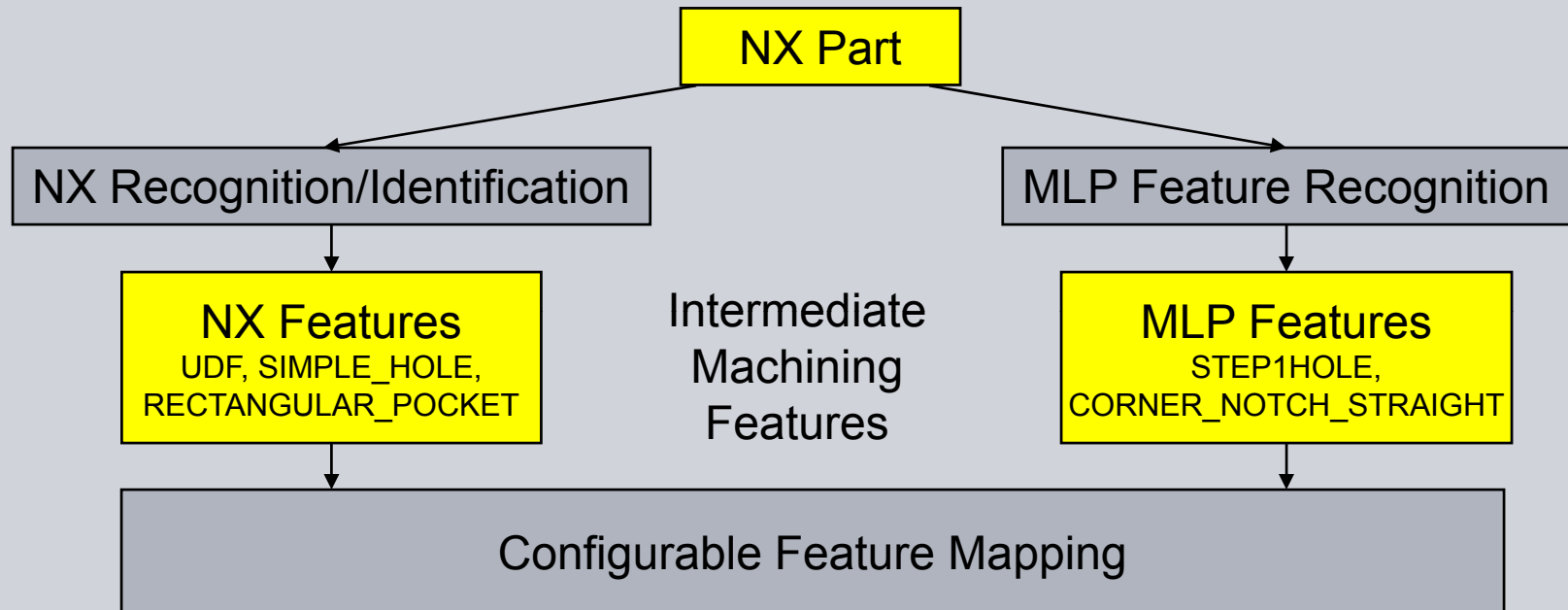
NX 6 FBM implementation:

- Feature Identification
- Feature mapping onto new parametric feature types
- Standard operations & tools



Machining Feature Recognition Projects

3. Configurable Machining Feature Mapping



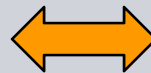
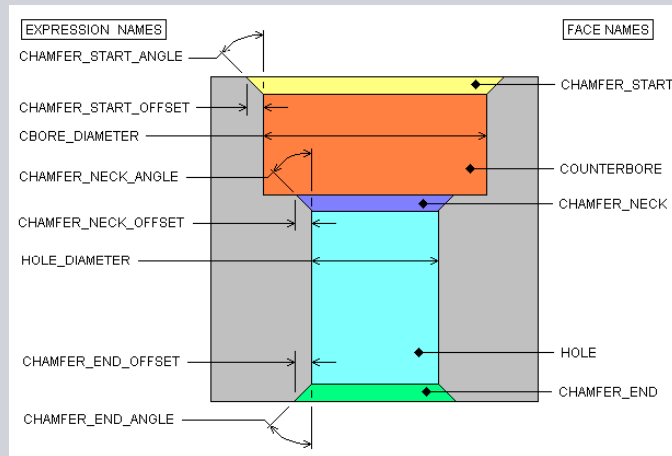
Machining Feature Navigator		
Feature Name	Geometry Group	Status
Features		
SIMPLE_HOLE_2		
SIMPLE_HOLE_3		
SIMPLE_HOLE_4		
THREADED_SIMPLE_HOLE_5		
THREADED_SIMPLE_HOLE_6		

Final Machining
Features as
presented to the
user

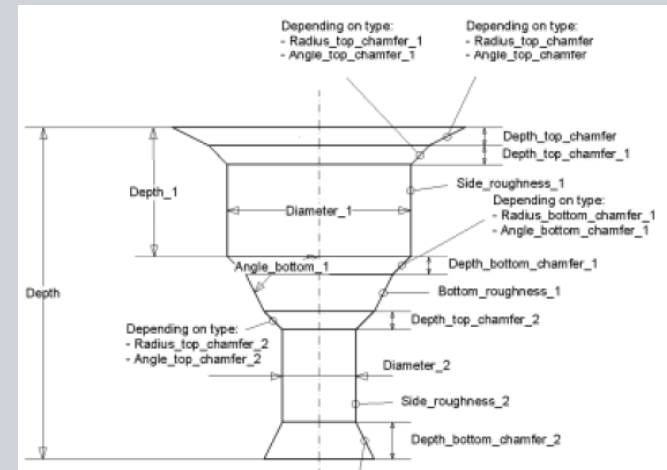
Machining Feature Recognition Projects

3. Configurable Machining Feature Mapping

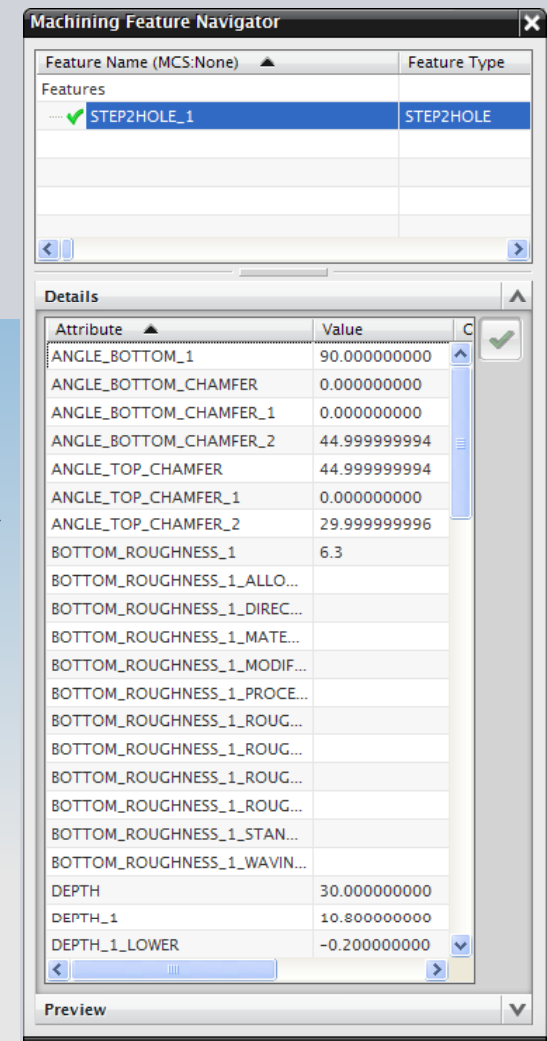
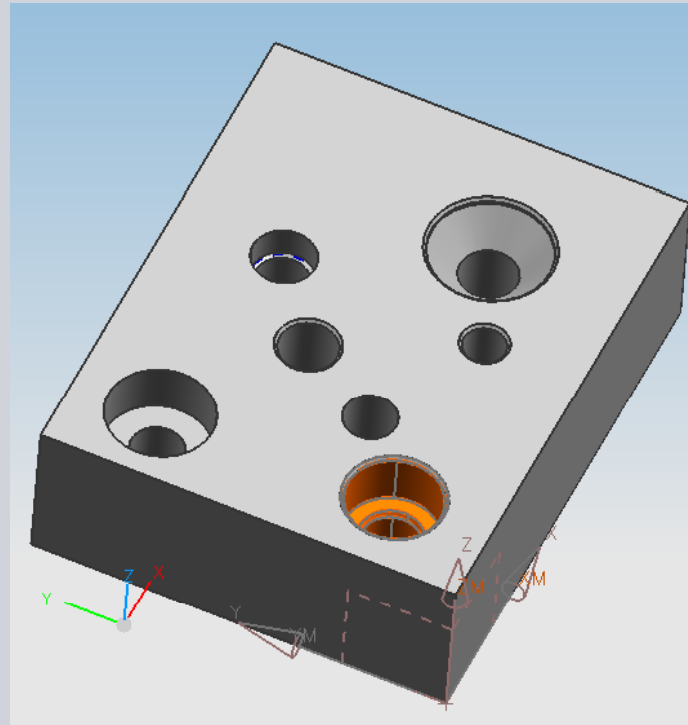
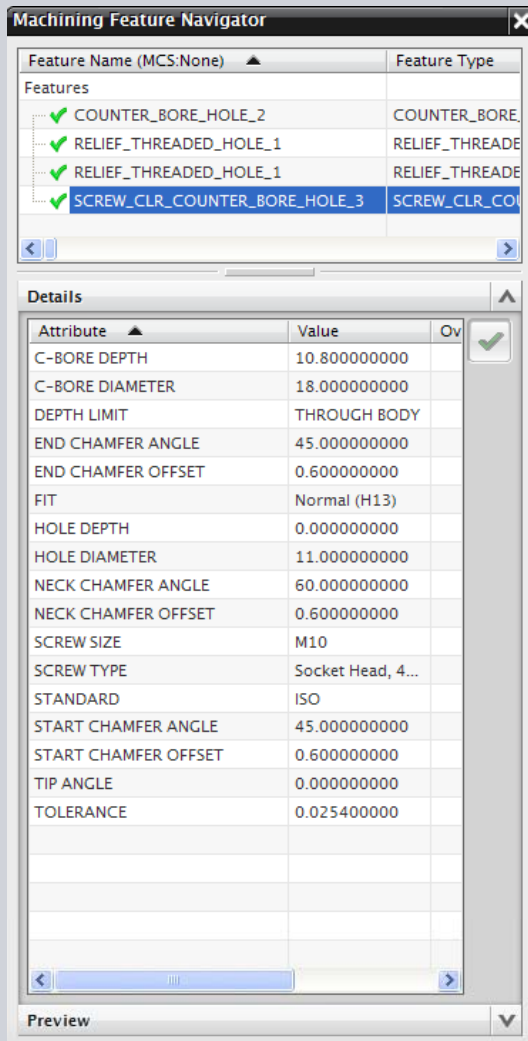
SCREW_CLR_COUNTER_BORE_HOLE



STEP2HOLE



Left: SCREW_CLR_COUNTER_BORE_HOLE
Right: STEP2HOLE



Default OOTB

map_SCREW_CLR_COUNTER_BORE_HOLE_to_S2H

SIEMENS

Machining Knowledge Editor - [feature_mapping_knowledge.xml]

File Edit View Window Help

RuleLibrary

- map_SIMPLE_HOLE_to_S1H
- map_SIMPLE_HOLE_to_S1P
- map_SCREW_CLR_COUNTER_BORE_HOLE_to_S2H
- map_SCREW_CLR_COUNTER_BORE_HOLE_to_S2P
- map_COUNTER_BORE_HOLE_to_S2H
- map_COUNTER_BORE_HOLE_to_S2P
- map_COUNTER_SUNK_HOLE_to_S1H
- map_COUNTER_SUNK_HOLE_to_S1P
- map_SCREW_CLR_SIMPLE_HOLE_to_S1H
- map_SCREW_CLR_SIMPLE_HOLE_to_S1P
- map_RELIEF_THREADED_HOLE_to_S2H_t
- map_RELIEF_THREADED_HOLE_to_S2P_t
- map_SCREW_CLR_COUNTER_SUNK_HOLE_to_S1P
- map_SCREW_CLR_COUNTER_SUNK_HOLE_to_S1H
- map_TAPERED_HOLE_to_PR_TAPERED
- map_THREADED_HOLE_to_S1H_t
- map_THREADED_HOLE_to_S1P_t
- map_DRILL_SIZE_SIMPLE_HOLE_to_S1P
- map_DRILL_SIZE_SIMPLE_HOLE_to_S1H

Name: map_SCREW_CLR_COUNTER_BORE_HOLE_to_S2H

OperationClass (oper.): DummyOperation

Priority: 1

OutputFeatures (mwf.): SCREW_CLR_COUNTER_BORE_HOLE

InputFeatures (lwf.): STEP2HOLE

Resources (tool):

Conditions Constants Materials Machines Explanation Image

REM Application Criteria

```
is_defined(mwf.DEPTH_LIMIT)
mwf.DEPTH_LIMIT = "THROUGH BODY"
$$ Mapping denied. This feature may map to a STEP2POCKET since it is not thru.
```

REM Less Worked Feature Attributes

```
lwf.COLOR = mwf.COLOR

lwf.DIAMETER_1 = mwf.C_BORE_DIAMETER
lwf.DIAMETER_1_UPPER = constant.LWF_DIAM_UP
lwf.DIAMETER_1_LOWER = constant.LWF_DIAM_LO

lwf.DEPTH_1 = mwf.C_BORE_DEPTH
lwf.DEPTH_1_LOWER = constant.LWF_DEPTH_LO
lwf.DEPTH_1_UPPER = constant.LWF_DEPTH_UP

lwf.ANGLE_BOTTOM_1 = 90

lwf.BOTTOM_ROUGHNESS_1 = constant.Reachable_Roughness_MILL_rough_str
lwf.SIDE_ROUGHNESS_1 = constant.Reachable_Roughness_MILL_rough_str
lwf.SIDE_ROUGHNESS_2 = constant.Reachable_Roughness_MILL_rough_str

lwf.DEPTH = mwf.HOLE_DEPTH
lwf.DEPTH_LOWER = constant.LWF_DEPTH_LO
lwf.DEPTH_UPPER = constant.LWF_DEPTH_UP

lwf.DIAMETER_2 = mwf.HOLE_DIAMETER
lwf.DIAMETER_2_UPPER = constant.LWF_DIAM_UP
REM just some possibilities of how we can interpret the FIT attribute...
IF mwf.FIT = "CLOSE(H12)" THEN lwf.DIAMETER_2_LOWER = 0 ELSE lwf.DIAMETER_2_LOWER = constant.LWF_DIAM_LO
IF mwf.FIT = "CLOSE(H12)" THEN lwf.Machining_Rule = "TWIST_DRILL"

lwf.ANGLE_BOTTOM_CHAMFER = mwf.END_CHAMFER_ANGLE
REM check on zero divide...
IF mwf.END_CHAMFER_ANGLE > 0 THEN lwf.DEPTH_BOTTOM_CHAMFER = mwf.END_CHAMFER_OFFSET/TAN(mwf.END_CHAMFER_ANGLE)

lwf.ANGLE_TOP_CHAMFER_2 = mwf.NECK_CHAMFER_ANGLE
REM check on zero divide...
IF mwf.NECK_CHAMFER_ANGLE > 0 THEN lwf.DEPTH_TOP_CHAMFER_2 = mwf.NECK_CHAMFER_OFFSET/TAN(mwf.NECK_CHAMFER_ANGLE)
```

Environment

ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources	ProductMaterials	Machines
Total									

Rule

Retrieved nodes (116 new, 0 reloaded)

NUM

Machining Feature Recognition Projects

3. Configurable Machining Feature Mapping



Allows customers that use their private best machining practice to benefit from the improved machining feature recognition

- By **mapping recognized features to customer specific UDF features**
- So existing automatic process selection can be applied to components that were not designed using customer specific UDF features

Allows customers using UDF based design to work with Siemens PLM NX 6 best machining practices even though that does not reference those UDF types

- By **mapping customer UDF features to standard NX/MLP features**

Automatic Machining Process & Tool Selection

Feature-based Machining NX 6 Process Selection Projects



1. Add a new Machining Knowledge Editor application
 - Provide a dedicated User Interface for code-less process customization
 - Select feature, operation and tool **classes** from pull-down menus
 - Select feature, operation and tool **attributes** from pull-down menu's
 - Full syntax checking
 - Does not require programming
 - Much easier to learn and use
 - Will significantly reduce the implementation time
2. Deliver OOTB Process Content for selected domain(s)
 - Features will get a set of “standard” processes
 - Customers can use the Machining Knowledge Editor to modify the standard content and further reduce the deployment time

Machining Knowledge Editor



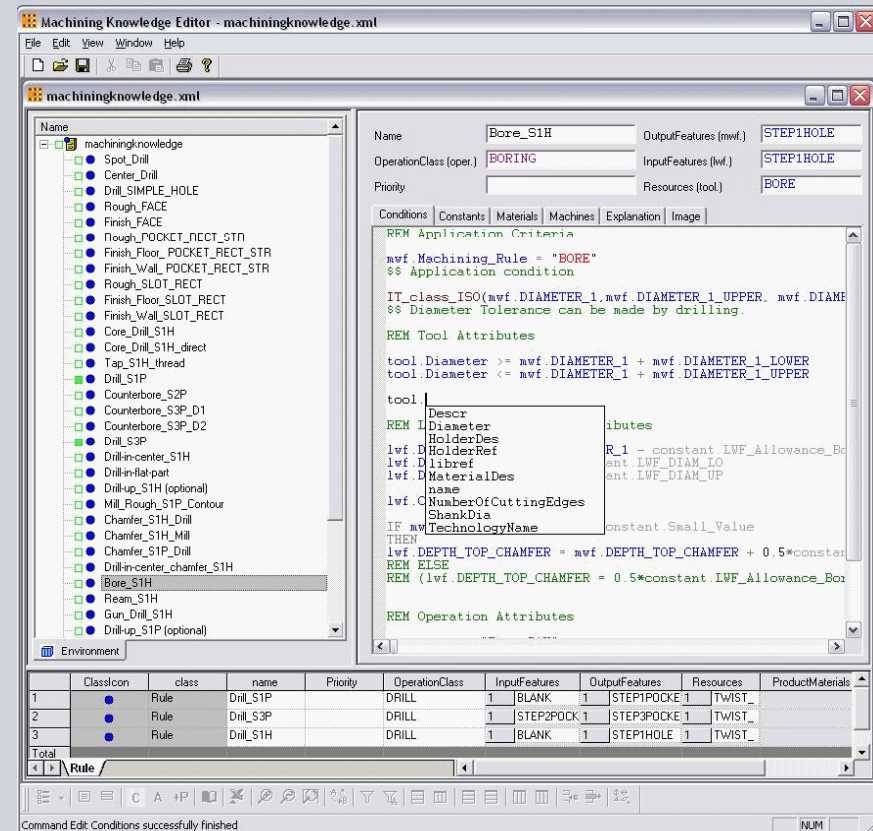
Machining Best Practice definition using the Machining Knowledge Editor

What is it?

- Go forward strategy for defining rules in FBM
- Helps you create and modify the rule libraries which define the best practice operations and tools required to machine features

Benefits

- Use the Machining Knowledge Editor to modify the standard machining knowledge supplied with NX or to define your company's best practices



Why are we adding the Machining Knowledge Editor?

Need to speed up the NX CAM automation deployment

- Single application to define, organize and document the rules
- User Interface to guide and support the user
- Knowledge management and distribution using Teamcenter
- Single set of criteria for metric and inch knowledge (no duplication)
- Excellent performance
- Training and online documentation material available

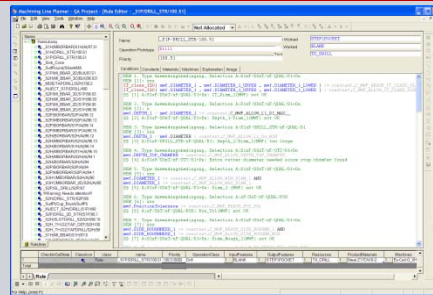
Offers a series of additional technical capabilities that will be integrated into future NX CAM versions:

- In-process features
- Compound operations for multiple features
- Creation (instead of selection) of new tools
- Supports rule teaching

Machining Knowledge Definition

How does it work? - Concept

Subject Matter Expert; configures the best practice machining processes
(Machining Knowledge Editor application)



Machining Knowledge Library

NX CAM loads the appropriate Machining Knowledge Library

NC Programmer (NX CAM)

Feature Name	Feature Type
COUNTER_BORE_HOLE_1	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_10	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_11	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_12	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_13	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_14	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_15	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_16	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_17	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_18	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_19	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_2	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_20	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_21	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_3	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_4	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_5	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_6	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_7	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_8	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_9	COUNTER_BORE_HOLE

Features

Machining Knowledge Library

Create Geometry... command

Name	Path
STANDARD_THREAD	
SPOT_DRILL_STD_THREAD	
DRILL_STD_THREAD	
THREAD_STD_THREAD	
STANDARD_THREAD_1	
STANDARD_THREAD_2	
CB_HOLE	
SPOT_DRILL_CB_HOLE	
DRILL_CB_HOLE	
CBORE_CB_HOLE	
CB_HOLE_1	

Operations

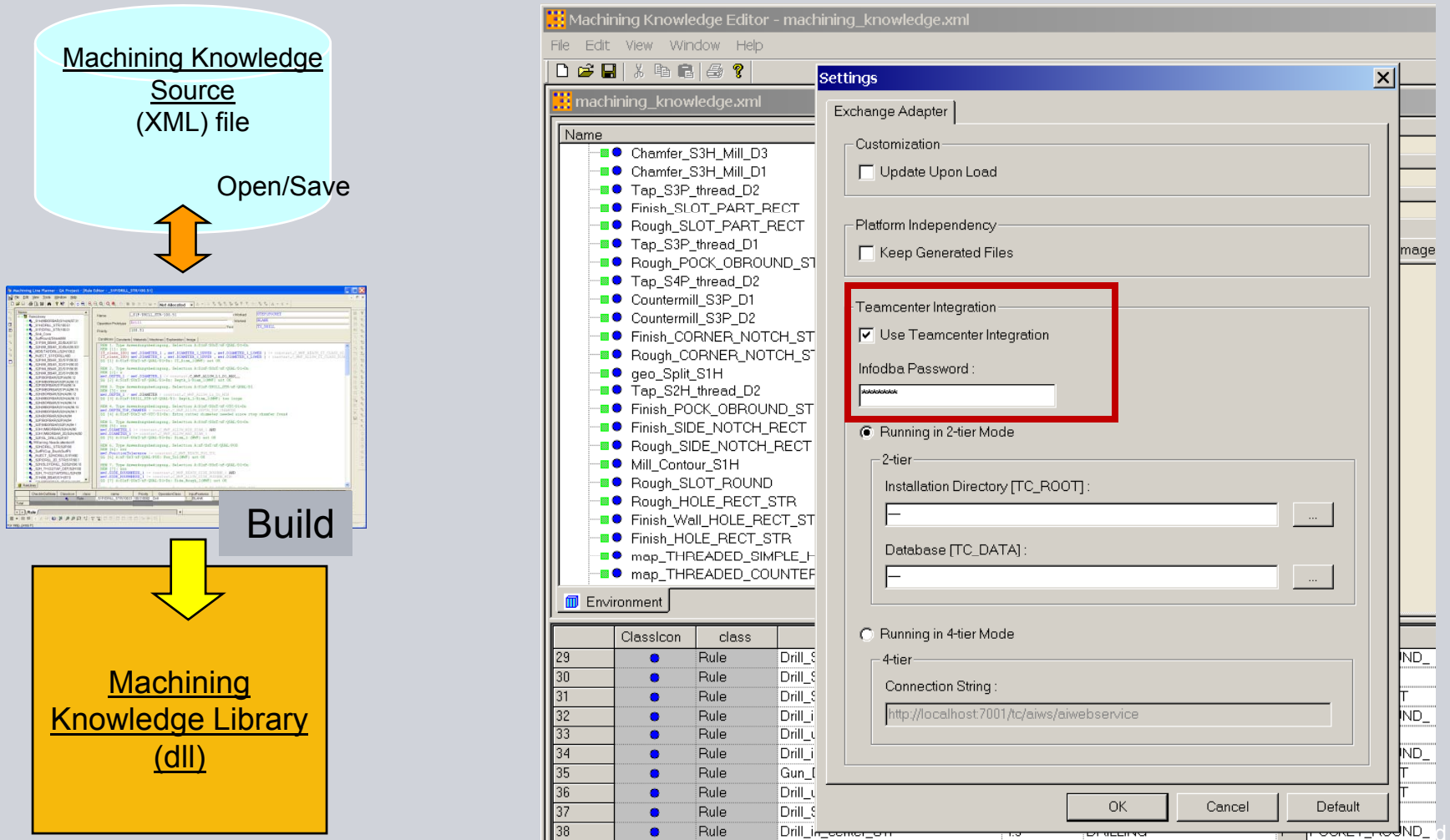
Tool Database
Teamcenter Resource
Manager or ASCII

Template Database
Teamcenter or native

Machining Knowledge Definition

How does it work? - Concept

- Managing of the knowledge data files can be done in Teamcenter



Machining Knowledge Definition

How does it work? - What is a unique operation?

Example machining processes for a hole

Through Drilling Hole (4)

Spot Drill → Drill 1 → Drill 2 → Chamfer

Through Boring Hole (4)

Spot Drill → Drill → Chamfer → Boring (Reaming)

Through Gun Drilling Hole (3)

Guide Hole → Gun Drill → Chamfer

Through Tapping Hole (4)

Spot Drill → Drill → Chamfer → Tapping



4 alternative sets of operations

15 operations overall

9 **unique** operations:

→ Spot Drill

Spot Drill → Drill

Drill → Drill

Drill → Chamfer

Chamfer → Boring, etc.

A unique operation can be used in different alternative sets of operations if it meets the criteria

Machining Knowledge Definition

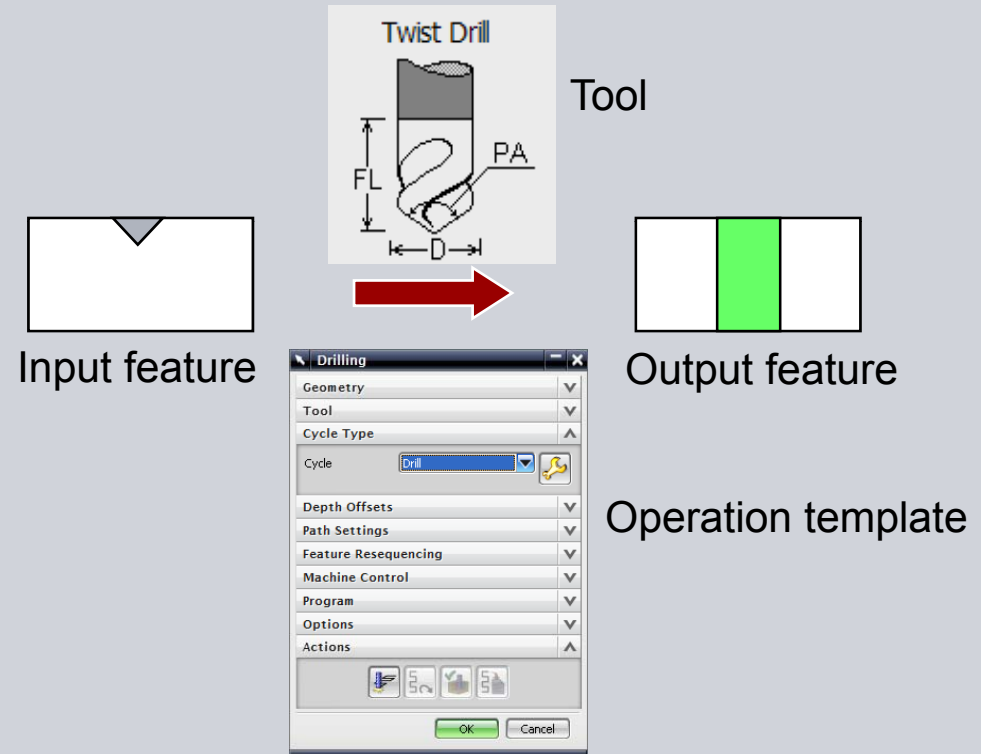
How does it work? - What is a unique operation

Mandatory Criteria:

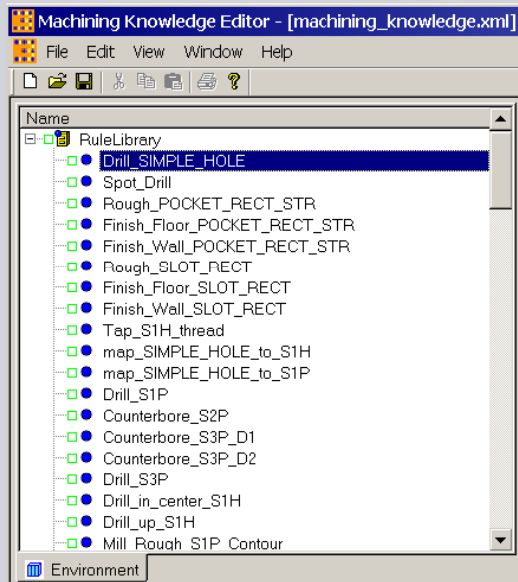
- When can an rule be used
 - Feature dimensions
 - Tolerances, etc.
- Which tool should be used
 - Type
 - Attributes
- Which operation template to use
 - Possibility to overrule template settings
 - Possibility to overrule Program and Method parents in the Operation Navigator

Optional Criteria:

- Workpiece Material
- Machine Tool type



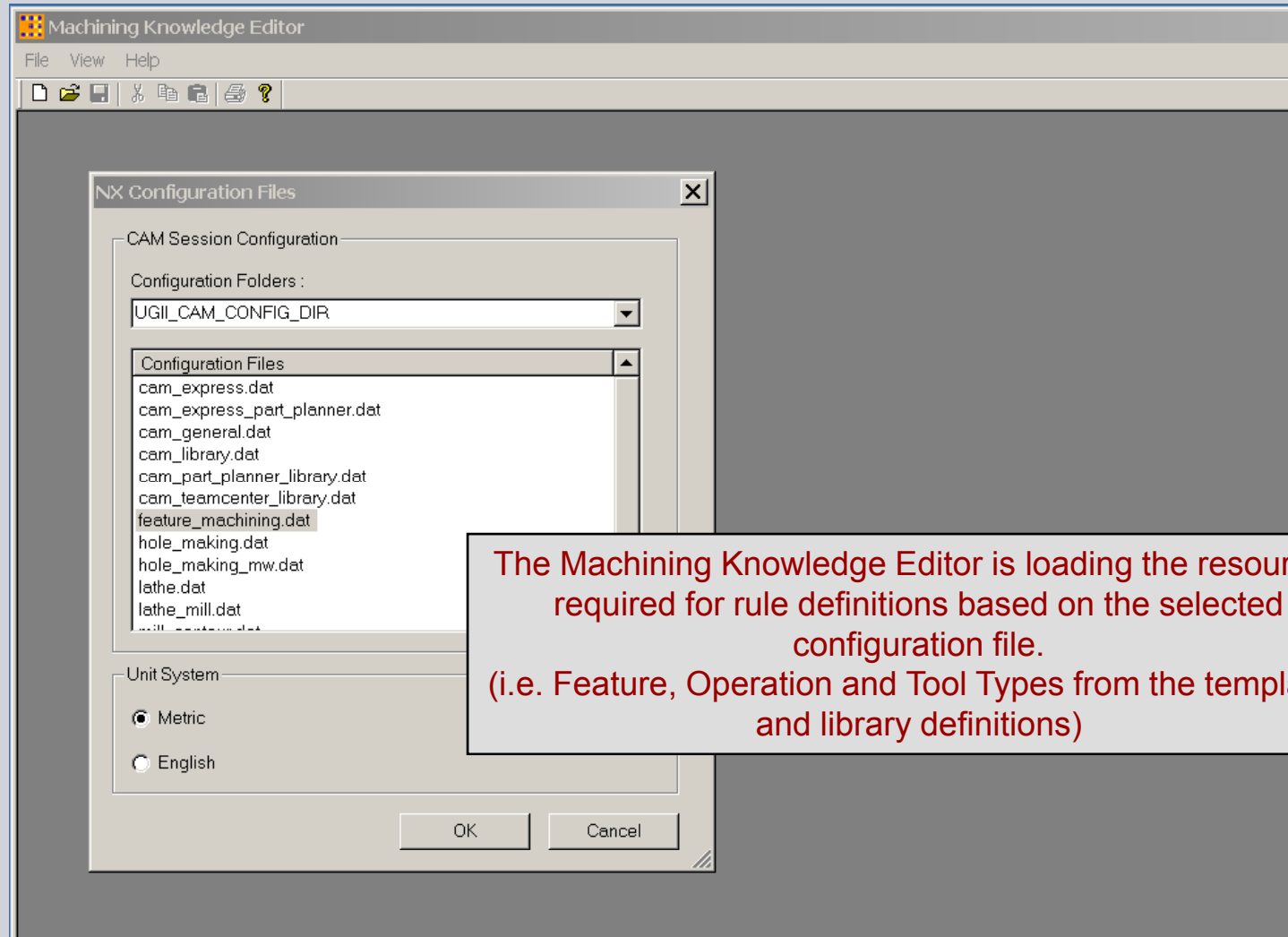
Machining Knowledge Definition Input Feature (lwf) / Output Feature (mwf)



Operation	Input Feature		Output Feature
Spot_Drill			
Drill_S1H			
Chamfer_S1H			
Tapping_S1H			

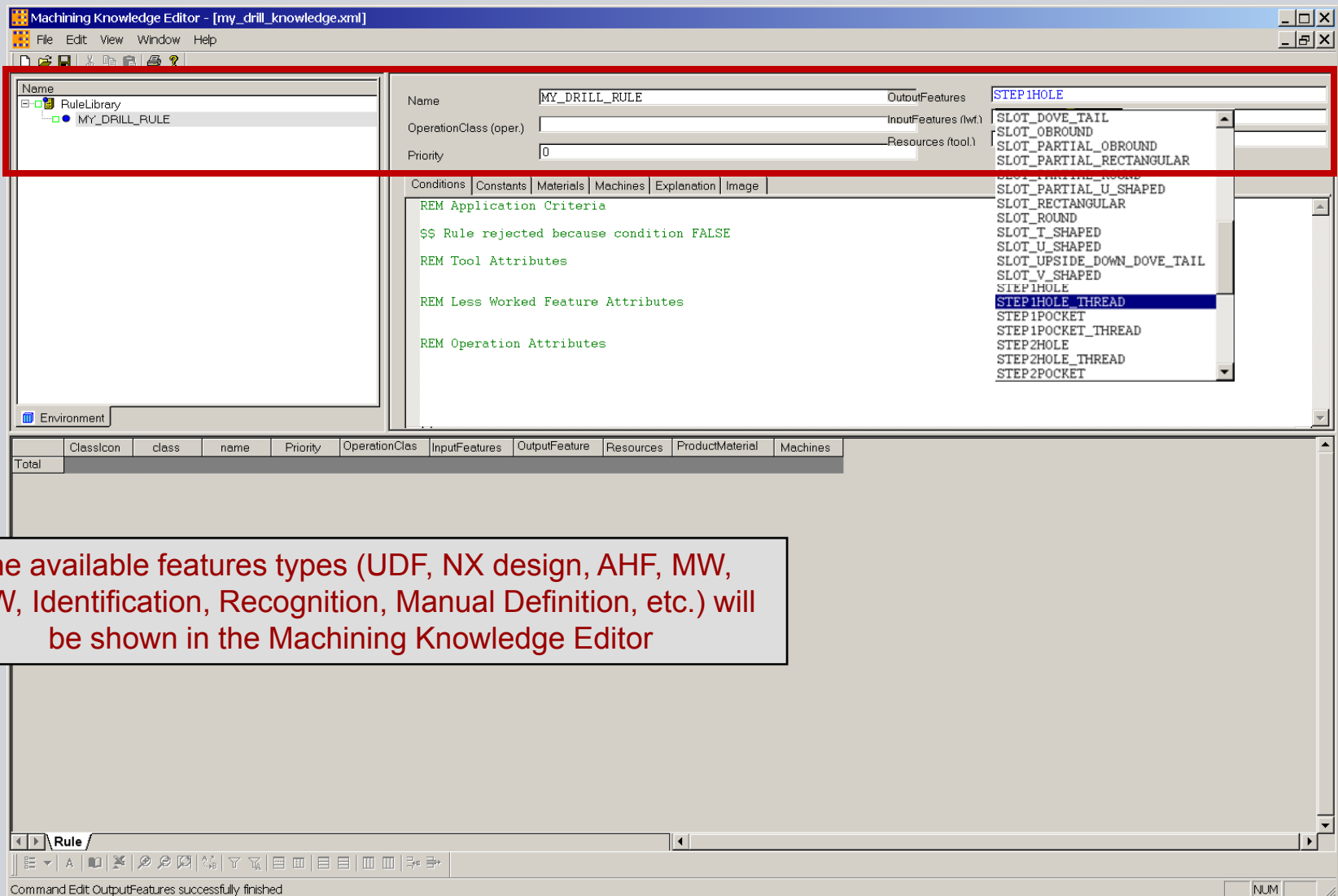
Machining Knowledge Editor

File New → Select CAM Session Configuration File



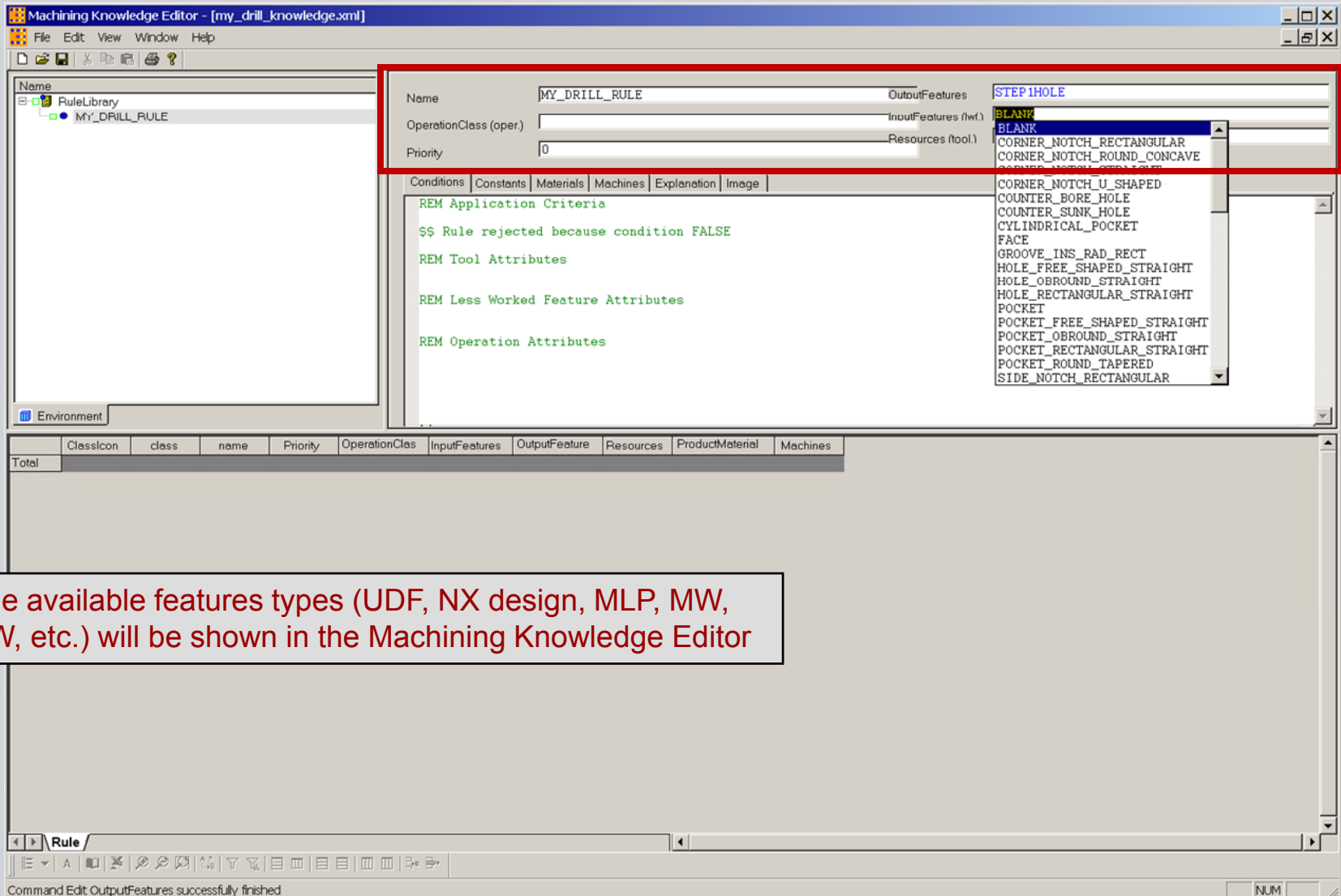
Machining Knowledge Editor

Create new rule → F8 → Select Output Feature (mwf)



Machining Knowledge Editor

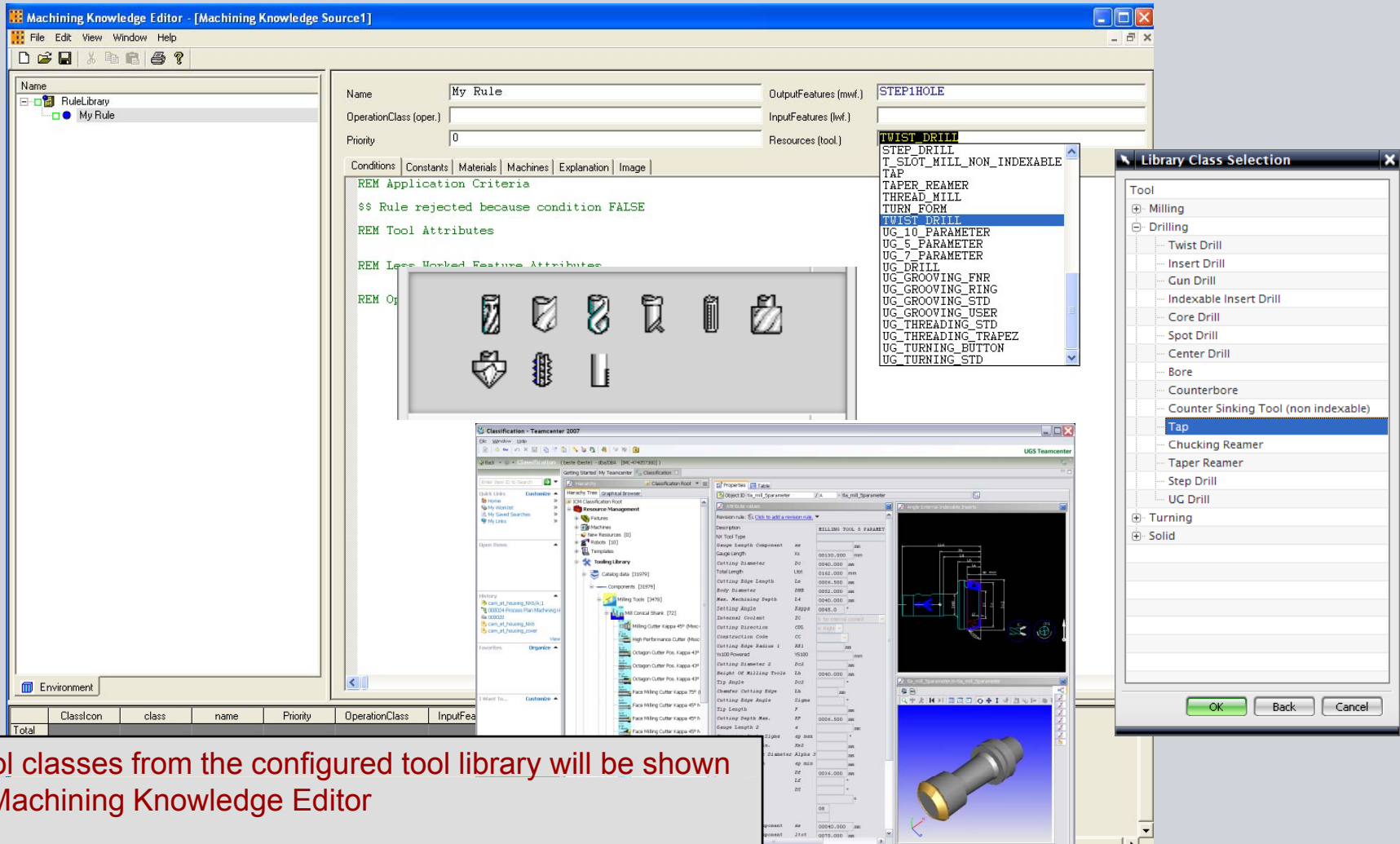
F8 → Select Input Feature (lwf)



The available features types (UDF, NX design, MLP, MW, PDW, etc.) will be shown in the Machining Knowledge Editor

Machining Knowledge Editor

F8 → Select Tool Type



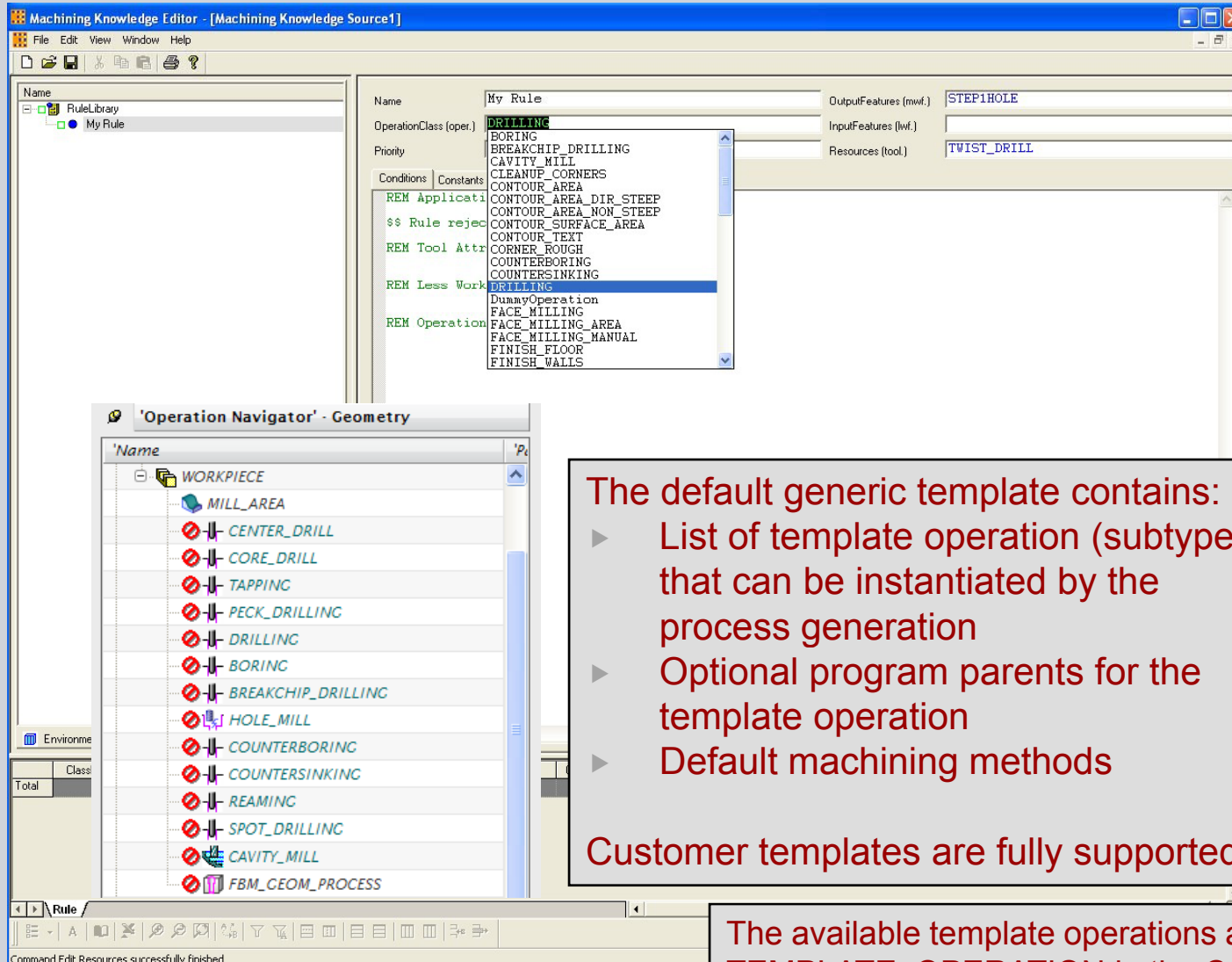
The tool classes from the configured tool library will be shown in the Machining Knowledge Editor

Tools from Resource Manager are fully supported

The available Tools are retrieved from LIBRARY_TOOL in the CAM Configuration

Machining Knowledge Editor

F8 → Select Template Operation



- The default generic template contains:
- ▶ List of template operation (subtypes) that can be instantiated by the process generation
 - ▶ Optional program parents for the template operation
 - ▶ Default machining methods

Customer templates are fully supported

The available template operations are retrieved from TEMPLATE_OPERATION in the CAM Configuration

Machining Knowledge Editor

SIEMENS

Set priority - highest priority = preferred (least expensive) process

The screenshot displays the Machining Knowledge Editor (MKE) interface. The left pane shows a tree view of the RuleLibrary with various rules like Drill_SIMPLE_HOLE, Spot_Drill, and Rough_POCKET_RECT_STR. The right pane shows the configuration for the Drill_SIMPLE_HOLE rule, including its Name, OperationClass (DRILLING), Priority (4.1), and various attributes like Conditions, Constants, Materials, Machines, Explanation, and Image. The Priority field is highlighted with a red box. Below the configuration pane is a table listing all rules in the library, with the Priority column also highlighted by a red box.

	ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeature	Resources	ProductMaterial	Machines
29		Rule	Drill_SIMPLE_HOLE	4.1	DRILLING	1 POCKET_ROUND	1 SIMPLE_H	1 TWIST		
30		Rule	Drill_S1P	4.2	DRILLING	1 BLANK	1 STEP1PO	1 TWIST		
31		Rule	Drill_S3P	4.9	DRILLING	1 STEP2POCKET	1 STEP3PO	1 TWIST		
32		Rule	Drill_in_center_S1H	4.4	DRILLING	1 POCKET_ROUND_	1 STEP1HOL	1 TWIST		
33		Rule	Drill_up_S1H	4.2	DRILLING	1 STEP1HOLE	1 STEP1HOL	1 TWIST		
34		Rule	Drill_in_center_chamfer_S1H	4.3	DRILLING	1 POCKET_ROUND_	1 STEP1HOL	1 TWIST		
35		Rule	Gun_Drill_S1H	1.1	DRILLING	1 STEP1POCKET	1 STEP1HOL	1 GUN_		
36		Rule	Drill_up_S1P	4.3	DRILLING	1 STEP1POCKET	1 STEP1PO	1 TWIST		
37		Rule	Drill_S1H	4.5	DRILLING	1 BLANK	1 STEP1HOL	1 TWIST		
38		Rule	Drill_in_center_S1P	4.5	DRILLING	1 POCKET_ROUND_	1 STEP1PO	1 TWIST		
39		Rule	Drill_in_center_chamfer_S1P	4.4	DRILLING	1 POCKET_ROUND_	1 STEP1PO	1 TWIST		
40		Rule	Gun_Drill_S1P	1.1	DRILLING	1 STEP1POCKET	1 STEP1PO	1 GUN_		
41		Rule	Spot_Drill_in_S1P	0	DRILLING	1 STEP1POCKET	1 POCKET_	1 SPOT_		
42		Rule	Spot_Face_S1P	3	DRILLING	1 BLANK	1 STEP1PO	1 END_		
43		Rule	Drill_S2H_in_S1P	4	DRILLING	1 STEP1POCKET	1 STEP2HOL	1 TWIST		
44		Rule	Drill_S2P_in_S1P	4	DRILLING	1 STEP1POCKET	1 STEP2PO	1 TWIST		
Total										

Machining Knowledge Editor

Define the conditions of the machining rules

The screenshot displays the Machining Knowledge Editor window with the following components:

- Left Panel (RuleLibrary):** Shows a tree structure with 'MY_DRILL_RULE' selected.
- Top Panel (Form Fields):**
 - Name: MY_DRILL_RULE
 - OperationClass (oper.): HOLE_MAKING
 - Priority: 0
 - OutputFeatures: STEP1HOLE
 - InputFeatures (InF.): BLANK
 - Resources (tool.): TWIST_DRILL
- Conditions Tab:** Contains the following text:


```

      REM Application Criteria
      mwf.DIAMETER_1 <= 8

      $$ Rule rejected because condition FALSE

      REM Tool Attributes
      tool.Diameter >= mwf.DIAMETER_1 + mwf.DIAMETER_1_LOWER
      tool.Diameter <= mwf.DIAMETER_1 + mwf.DIAMETER_1_UPPER
      tool.FluteLength > mwf.DEPTH

      REM Less Worked Feature Attributes

      REM Operation Attributes
      oper.Maximum_Depth_Distance = mwf.DEPTH + 0.5
      oper.Control_Point_Type = "1"
      
```
- Right Panel (List Views):**
 - oper.Depth:** A list containing DeltaDepth, Depth (selected), DepthExtend, DWELL, EffectiveDiameter, and emWorkplaceName.
 - tool.Cutter_LENGTH_D1:** A list containing Cutter_FIRST_CUT_TYPE, Cutter_GRINDING_LENGTH, Cutter_INTERN_COOLANT_Y_N, Cutter_LENGTH_D1 (selected), Cutter_ROTATION_CW_CCW, and Cutter_TAP_TYPE.
- Bottom Panels (Operation Navigators):**
 - Operation Navigator - Program Order:** Shows a tree with 'NC_PROGRAM' expanded, listing 'Unused Items', '1234', 'SPOT_DRILL', 'DRILL' (selected), 'COUNTERBORE', 'COUNTERSINK', and 'TAP'.
 - Operation Navigator - Machining Method:** Shows a tree with 'METHOD' expanded, listing 'Unused Items', 'MILL_ROUGH', 'MILL_SEMI_FINISH', 'MILL_FINISH', 'DRILL_METHOD' (selected), 'SPOT_DRILL_METHOD', 'PRE_DRILL_METHOD', 'STANDARD_DRILL_METHOD', 'CORE_DRILL_METHOD', 'DEBURRING_METHOD', and 'REAMING_METHOD'.

The definition of Operation Navigator parents is optional:

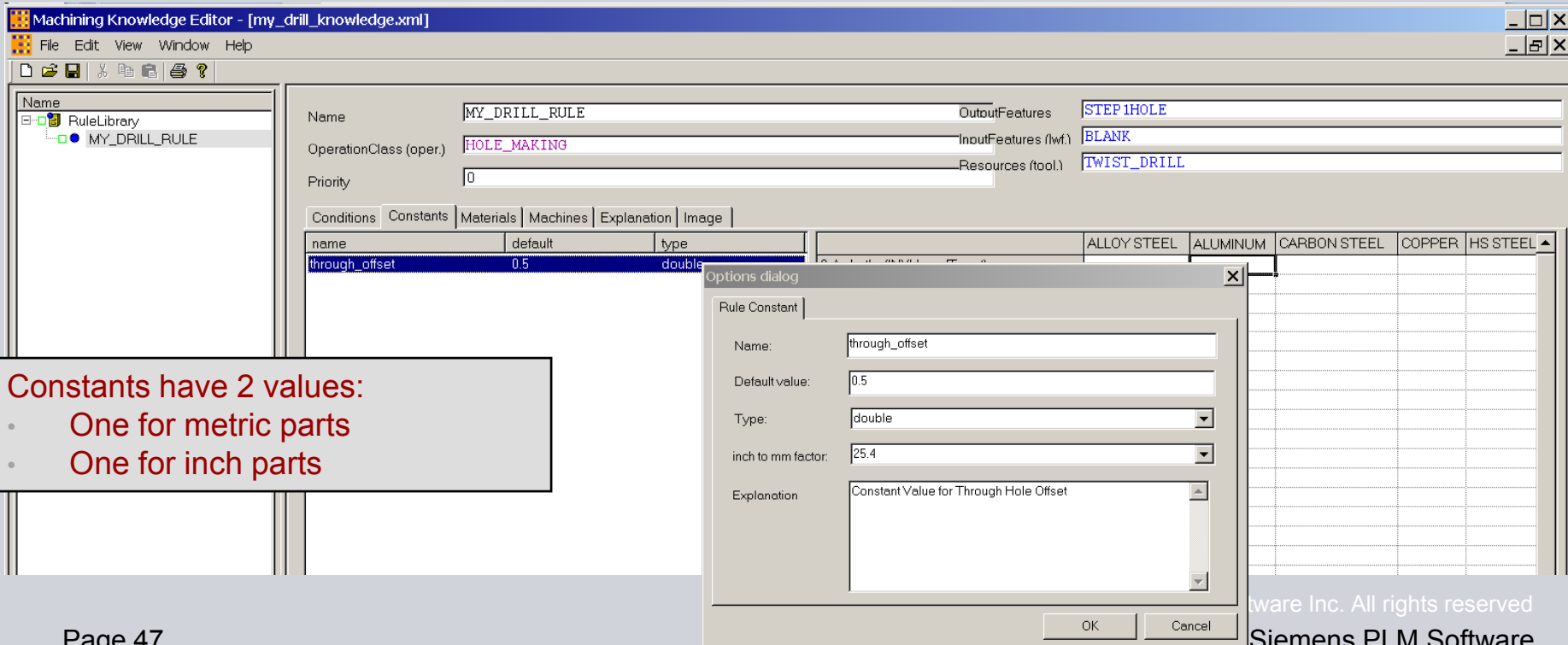
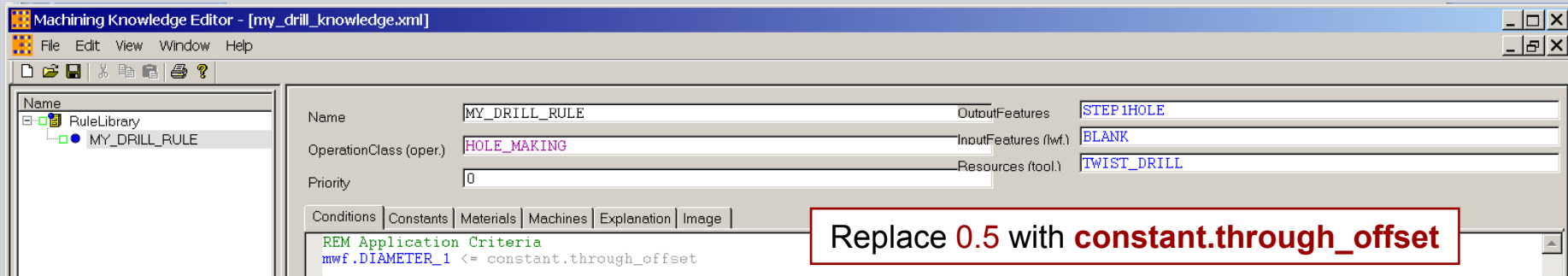
oper.METHOD_GROUP = "DRILL_METHOD"
oper.PROGRAM_ORDER_GROUP = "DRILL"

Free text editing (manual typing, delete, insert, copy, paste, etc.)
Standard windows shortcuts (Cut/Copy/Paste, Undo/Redo, Find/Replace/F3, etc.)

Machining Knowledge Editor

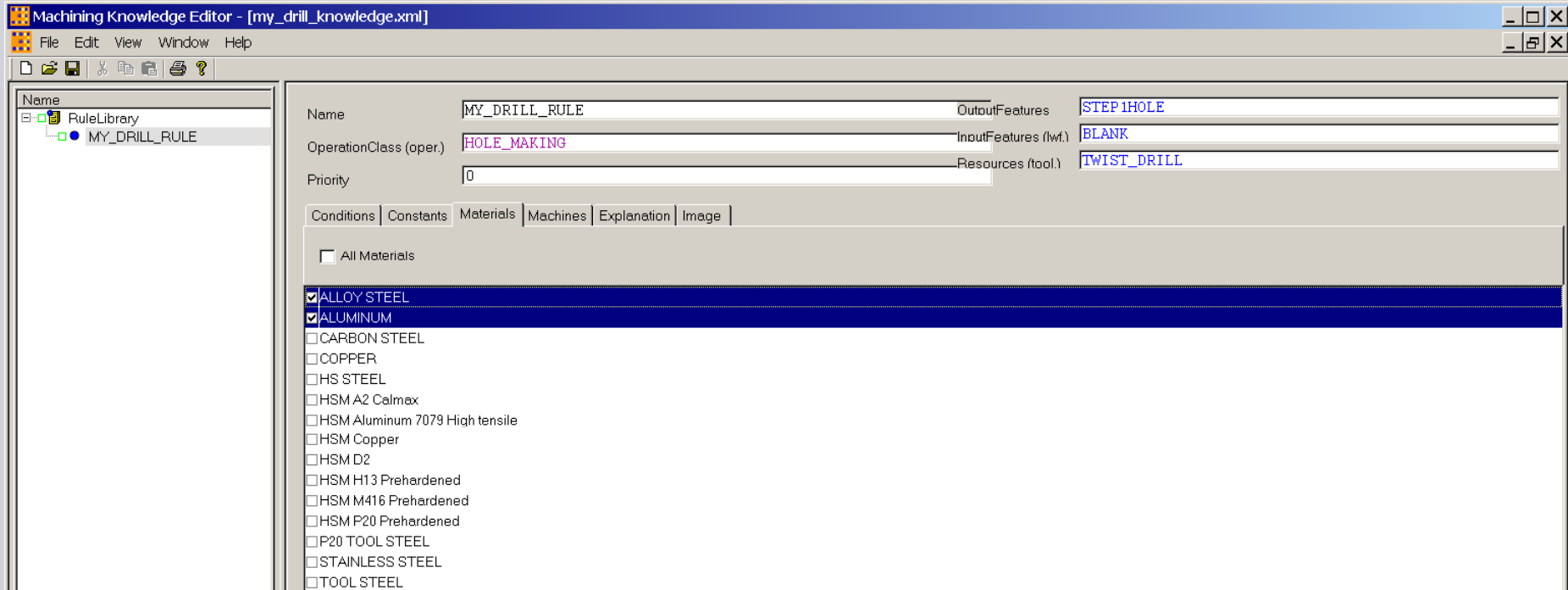
Use constants for transparency

SIEMENS



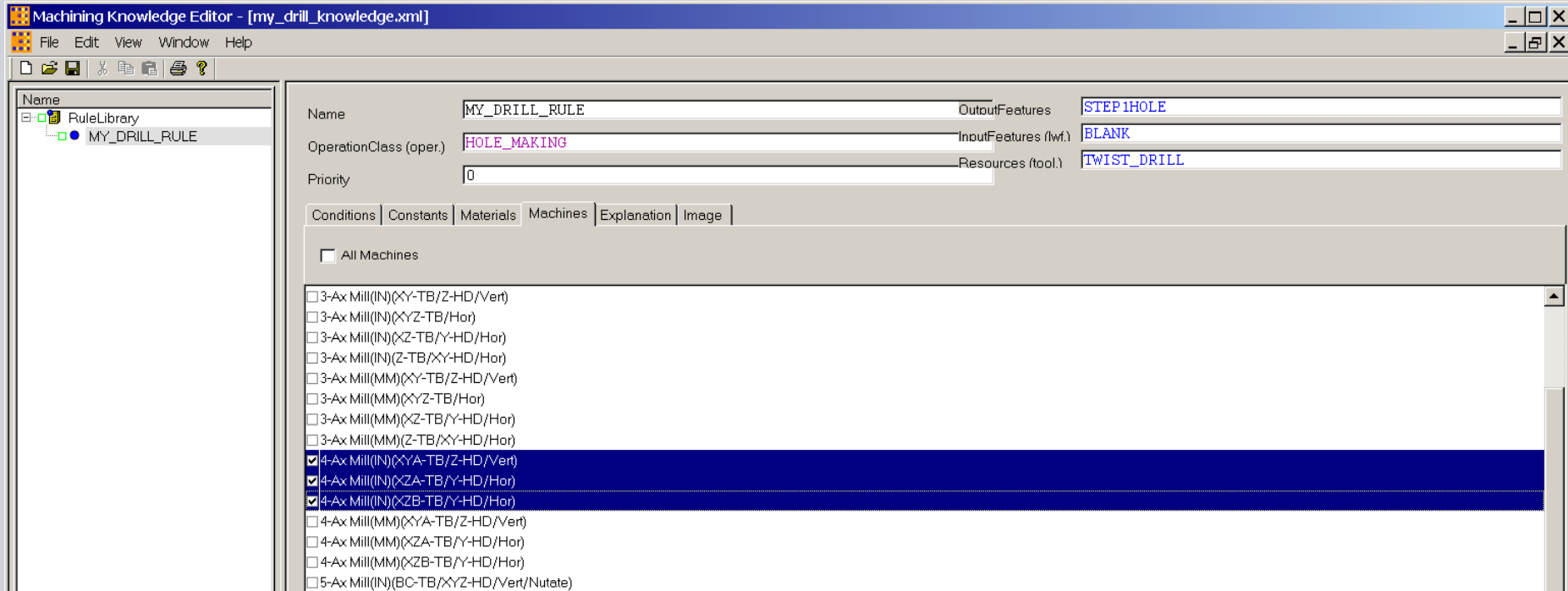
Machining Knowledge Editor

Rules can be valid for a subset of materials



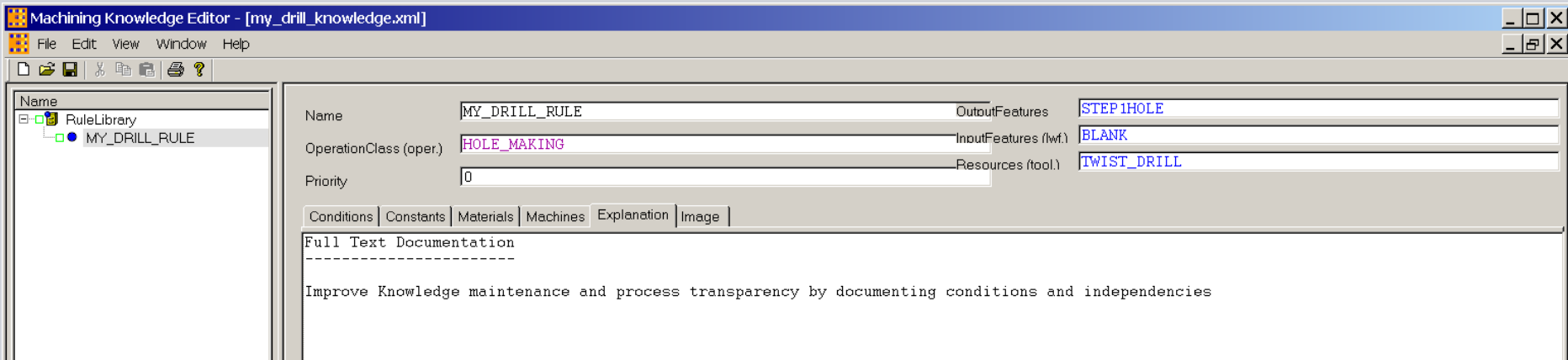
Machining Knowledge Editor

Rules can be valid for a subset of machines



Machining Knowledge Editor

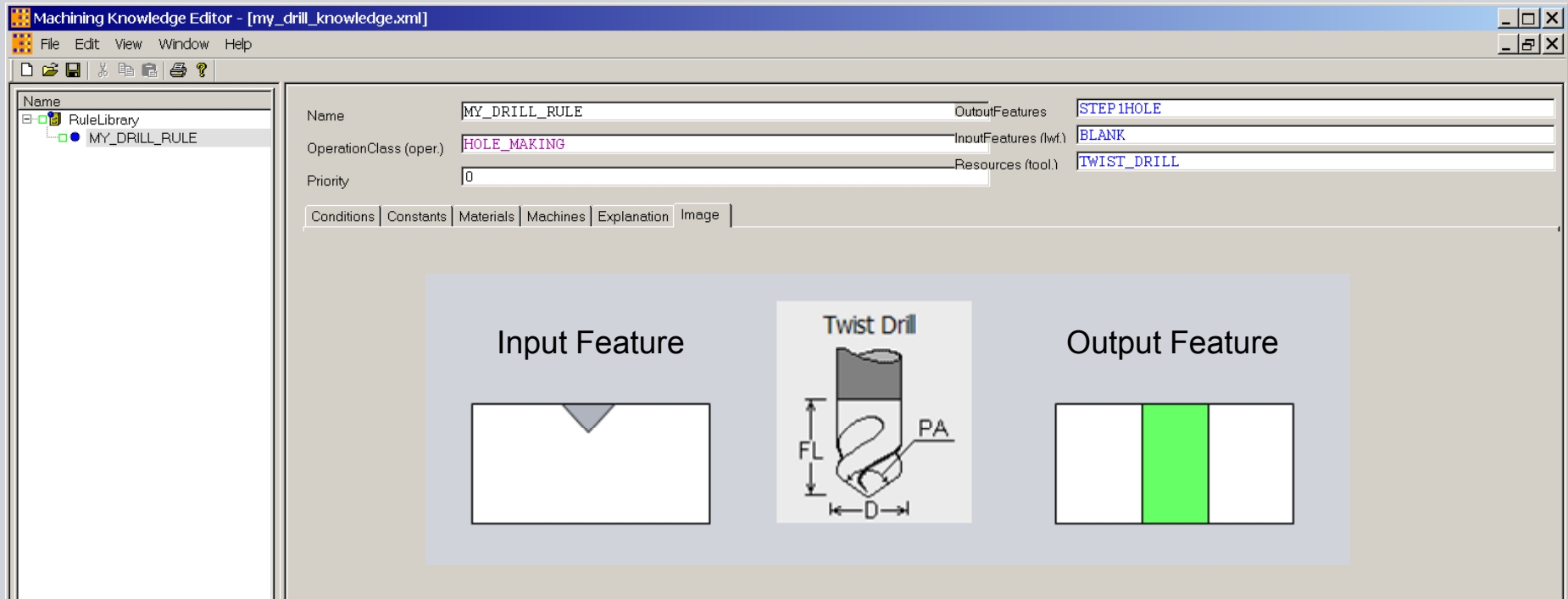
Provide Rule Explanation



Simplify knowledge maintenance and enhance process transparency by documenting conditions and dependencies

Machining Knowledge Editor

Provide Rule Image



Machining Knowledge Editor

Use Table View to find rules

	ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
1	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)
2	●	Rule	Bore_S1H		BORING	1 STEP1HOLE	1 STEP1HOLE	1 BORE
3	●	Rule	Center_Drill	-100	CENTER_DRILL_MK	1 BLANK	1 POCKET_ROUND_TAPERED	1 CENTER_DRILL
4	●	Rule	Chamfer_S1H_Drill	1	SPOT_DRILLING	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
5	●	Rule	Chamfer_S1H_Mill		PLANAR_PROFILE	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
6	●	Rule	Chamfer_S1P_Drill	1	SPOT_DRILLING	1 STEP1POCKET	1 STEP1POCKET	1 COUNTER_SINKING
7	●	Rule	Counterbore_S2P		COUNTERBORING	1 STEP1POCKET	1 STEP2POCKET	1 COUNTER_BORE
8	●	Rule	Counterbore_S3P_D1		COUNTERBORING	1 STEP2POCKET	1 STEP3POCKET	1 COUNTER_BORE
9	●	Rule	Counterbore_S3P_D2		COUNTERBORING	1 STEP2POCKET	1 STEP3POCKET	1 COUNTER_BORE
10	●	Rule	Drill-in-center_chamfer_S1H		DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
11	●	Rule	Drill-in-center_S1H		DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
12	●	Rule	Drill-in-center_S1P		DRILL	1 POCKET_ROUND_TAPERED	1 STEP1POCKET	1 TWIST_DRILL
13	●	Rule	Drill-in-flat-part		DRILL	1 STEP1POCKET	1 STEP1HOLE	1 TWIST_DRILL
14	●	Rule	Drill-up_S1H (optional)		DRILL	1 STEP1HOLE	1 STEP1HOLE	1 TWIST_DRILL
15	●	Rule	Drill-up_S1P (optional)		DRILL	1 STEP1POCKET	1 STEP1POCKET	1 TWIST_DRILL
16	●	Rule	Drill_S1H		DRILL	1 BLANK	1 STEP1HOLE	1 TWIST_DRILL
17	●	Rule	Drill_S1P		DRILL	1 BLANK	1 STEP1POCKET	1 TWIST_DRILL
18	●	Rule	Drill_S3P		DRILL	1 STEP2POCKET	1 STEP3POCKET	1 TWIST_DRILL

Excel Style User Interface

	ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
1	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)
5	●	Rule	Rough_POCKET_RECT_STR	1	FACE_MILLING_AREA	(All)	(All)	1
6	●	Rule	Finish_Floor_POCKET_RECT_STR	2	FACE_MILLING_AREA	(All)	(All)	1
7	●	Rule	Finish_Wall_POCKET_RECT_STR	3	FACE_MILLING_AREA	(All)	(All)	1
Total								

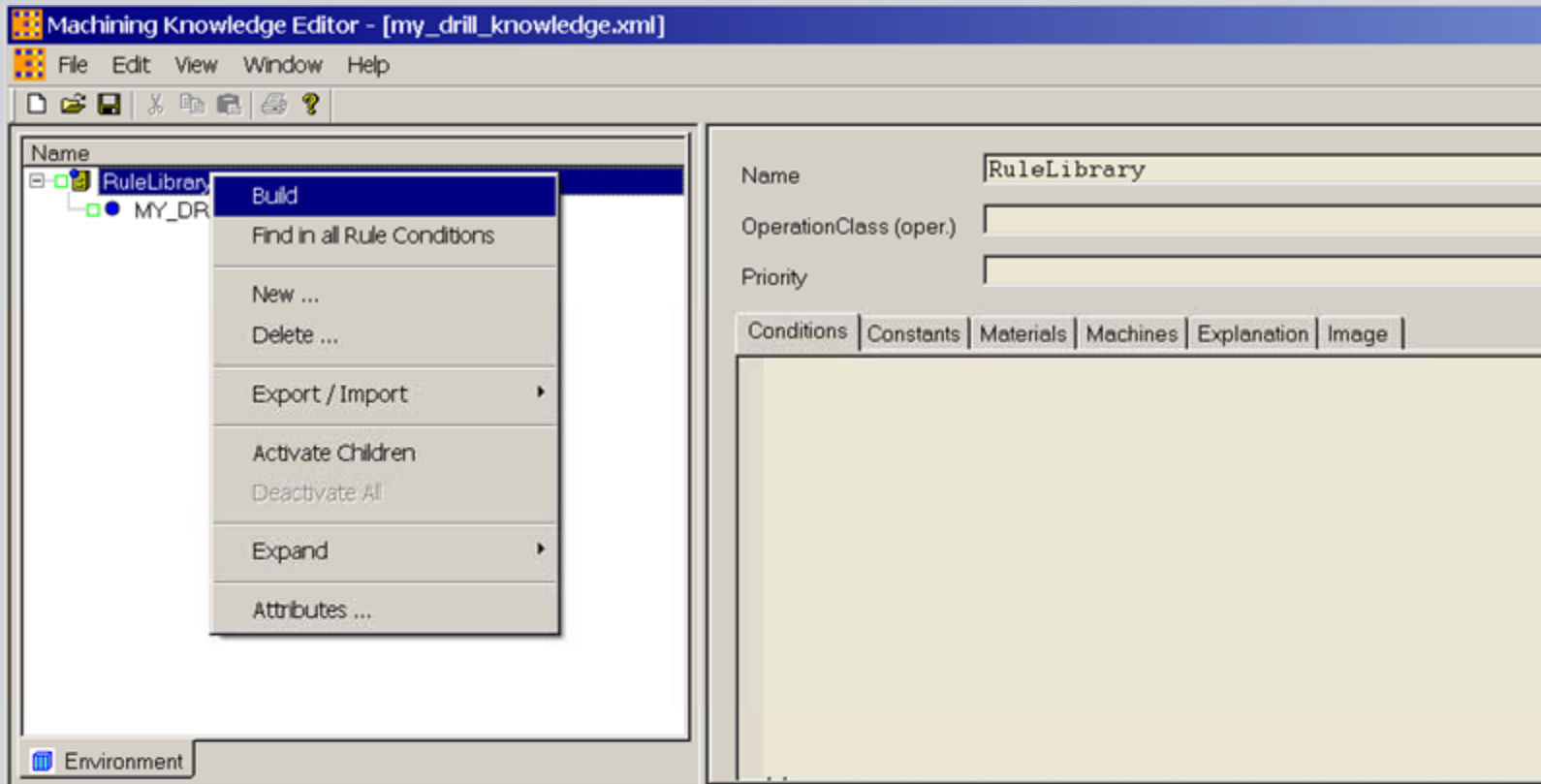
Rule

	ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
1	(All)	(All)	(All)	(All)	(All)	(All)	(All)	(All)
2	●	Rule	Drill_SIMPL	4.1	DRILLING	(All)	(All)	1
3	●	Rule	Spot_Drill	1	SPOT_DRILLING	(Custom...)	(All)	1
4	●	Rule	Rough_POC	3.1	FACE_MILLING	BLANK	(All)	1
5	●	Rule	Finish_Floor	3.2	FACE_MILLING	CORNER_NOTCH_STR	(All)	1
6	●	Rule	Finish_Wall	3.3	FACE_MILLING	HOLE_RECTANGULAR	(All)	1
7	●	Rule	Rough_SLO	3.1	FACE_MILLING	POCKET_OBROUND_S	(All)	1
8	●	Rule	Finish_Floor	3.2	FACE_MILLING	POCKET_RECTANGULA	(All)	1
9	●	Rule	Finish_Wall	3.3	FACE_MILLING	SLOT_RECTANGULA	(All)	1
10	●	Rule	Tap_S1H_th	0	TAPPING	1 STEP1HOLE	(All)	1
11	●	Rule	map_SIMPL	100	DummyOperatio	1 STEP1HOLE	(All)	1
12	●	Rule	map_SIMPL	100	DummyOperatio	1 STEP1POCKET	(All)	1
13	●	Rule	Drill_S1P	4.2	DRILLING	1 BLANK	(All)	1
14	●	Rule	Counterbore	2	COUNTERBORI	1 STEP1POCKET	(All)	1
15	●	Rule	Counterbore	2	COUNTERBORI	1 STEP2POCKET	(All)	1
16	●	Rule	Counterbore	2	COUNTERBORI	1 STEP2POCKET	(All)	1
17	●	Rule	Drill_S3P	4.9	DRILLING	1 STEP2POCKET	(All)	1
18	●	Rule	Drill_in_cent	4.4	DRILLING	1 POCKET_ROUND_TA	(All)	1
19	●	Rule	Drill_up_S1	4.2	DRILLING	1 STEP1HOLE	(All)	1
20	●	Rule	Mill_Rough	3.2	HOLE_MILL	1 STEP1POCKET	(All)	1

Rule

Machining Knowledge Editor

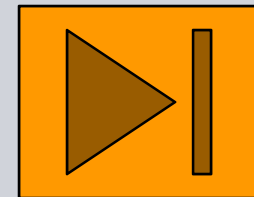
MB3 → Build on Rule Library node



Is building the knowledge library (dll) at UGII_CAM_MACHINING_KNOWLEDGE_DIR (NX native mode)
Is building the knowledge library (dll) and saves it back into Teamcenter (TC mode)

Rule Based Operations for Features (Operation selection component)

Inference Engine



Operation selection component (Inference Engine)

What is it?

- *Rule-based operation selection* is a proven technology seamlessly integrated into NX 6 that helps you automatically create operations such as milling, drilling and tapping from a generic template
- Lets you select features such as holes, slots, and pockets from any source, including features that are User Defined, identified, recognized or tagged
- Apply best practice machining rules on the features while taking into account any defined PMI

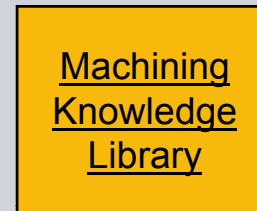
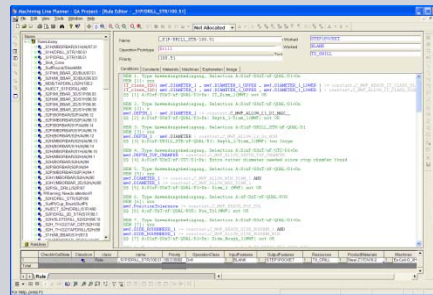
Benefits

- Standardize on best practice machining knowledge. The software finds the best solution for machining task within a company's environment.
- Save time with process automation

Machining Knowledge Definition

How does it work? - Concept

Subject Matter Expert; configures the best practice machining processes
(Machining Knowledge Editor application)

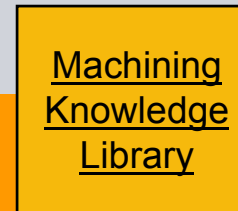


NX CAM loads
the appropriate
Machining
Knowledge Library

NC Programmer
(NX CAM)

Feature Name	Feature Type
COUNTER_BORE_HOLE_1	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_10	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_11	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_12	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_13	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_14	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_15	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_16	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_17	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_18	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_19	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_2	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_20	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_21	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_3	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_4	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_5	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_6	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_7	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_8	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_9	COUNTER_BORE_HOLE

Features

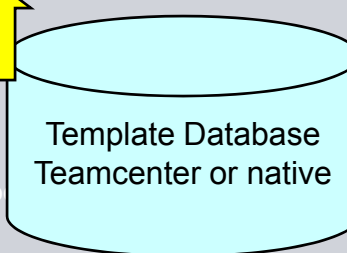
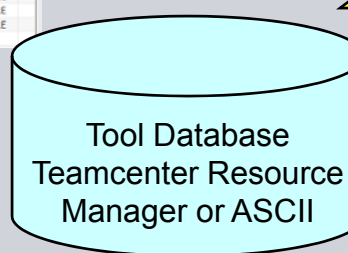


Create Geometry...
command



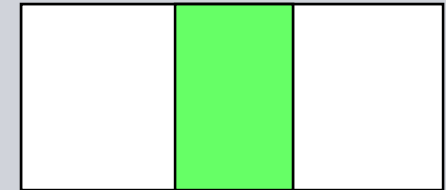
Name	Path
STANDARD_THREAD	
SPOT_DRILL_STD_THREAD	X
DRILL_STD_THREAD	X
THREAD_STD_THREAD	X
STANDARD_THREAD_1	
STANDARD_THREAD_2	
CB_HOLE	
SPOT_DRILL_CB_HOLE	X
DRILL_CB_HOLE	X
CBORE_CB_HOLE	X
CB_HOLE_1	

Operations



How does the Operation Selection work?

Example



BLANK



STEP1HOLE

The lwf (Required Input Feature) would be a Blank

Diameter tolerance (H7) can NOT be reached with this drilling process

List of **alternative** rules that can produce a STEP1HOLE feature (Output Feature)

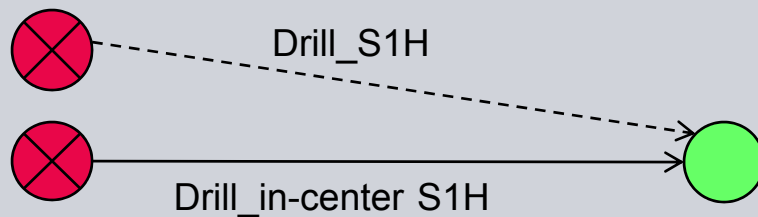
name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
(All)	(All)	(All)	(All)	STEP1HOLE	(All)
Gun_Drill_S1H	10	DRILL	1 STEP1POCKET	1 STEP1HOLE	1 GUN_DRILL
Bore_S1H	20	BORING	1 STEP1HOLE	1 STEP1HOLE	1 BORE
Ream_S1H	30	REAM	1 STEP1HOLE	1 STEP1HOLE	1 TAPER_REAMER
Chamfer_S1H_Mill	50	PLANAR_PROFILE	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Chamfer_S1H_Drill	60	SPOT_DRILLING	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Drill-up_S1H (optional)	80	DRILL	1 STEP1HOLE	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center_chamfer_S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center_S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill_S1H	100	DRILL	1 BLANK	1 STEP1HOLE	1 TWIST_DRILL



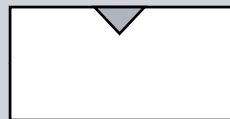
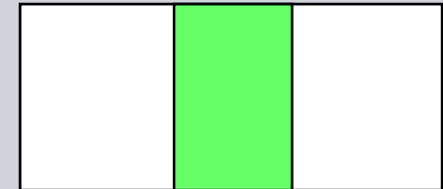
Start with highest priority rule = preferred (least expensive) process

How does the Operation Selection work?

Example



STEP1HOLE
Ø12H7



POCKET_ROUND_TAPERED

STEP1HOLE

The lwf (Required Input Feature) would be POCKET_ROUND_TAPERED

Diameter tolerance (H7) can also NOT be reached with this drilling process

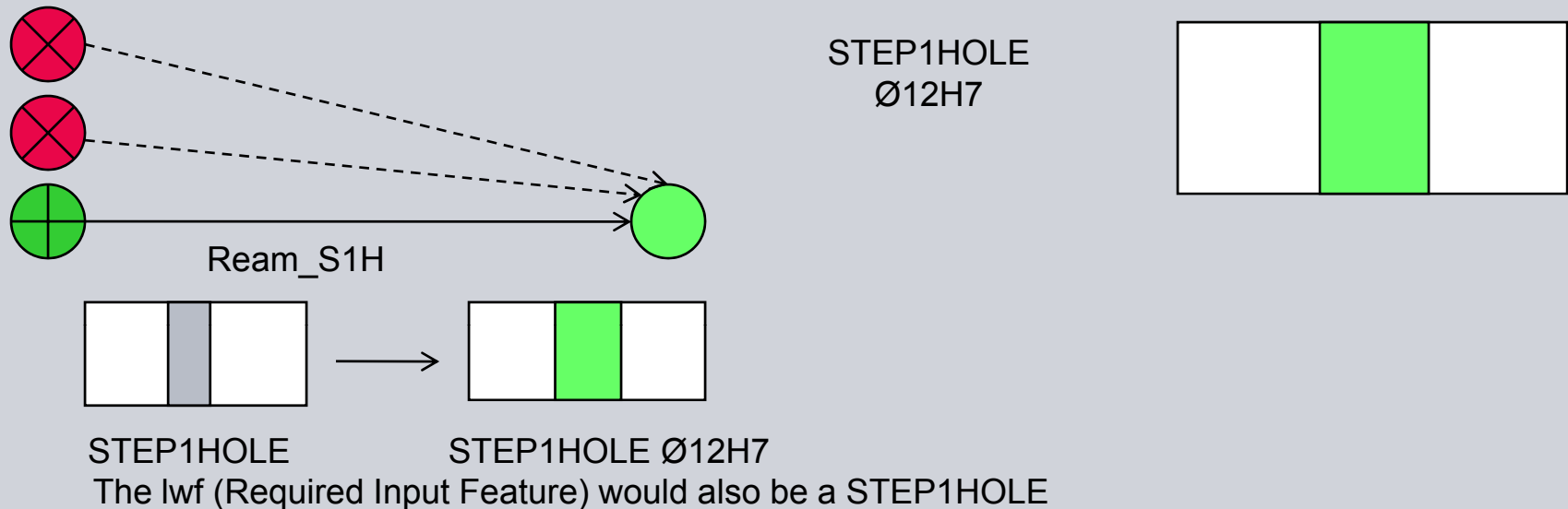
name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
(All)	(All)	(All)	(All)	STEP1HOLE	(All)
Gun_Drill_S1H	10	DRILL	1 STEP1POCKET	1 STEP1HOLE	1 GUN_DRILL
Bore_S1H	20	BORING	1 STEP1HOLE	1 STEP1HOLE	1 BORE
Ream_S1H	30	REAM	1 STEP1HOLE	1 STEP1HOLE	1 TAPER_REAMER
Chamfer_S1H_Mill	50	PLANAR_PROFILE	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Chamfer_S1H_Drill	60	SPOT_DRILLING	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Drill-up_S1H (optional)	80	DRILL	1 STEP1HOLE	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center chamfer S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill_S1H	100	DRILL	1 BLANK	1 STEP1HOLE	1 TWIST_DRILL



Try next higher priority rule

How does the Operation Selection work?

Example



The Reaming process is suitable (all conditions are TRUE) to produce a toleranced STEP1HOLE

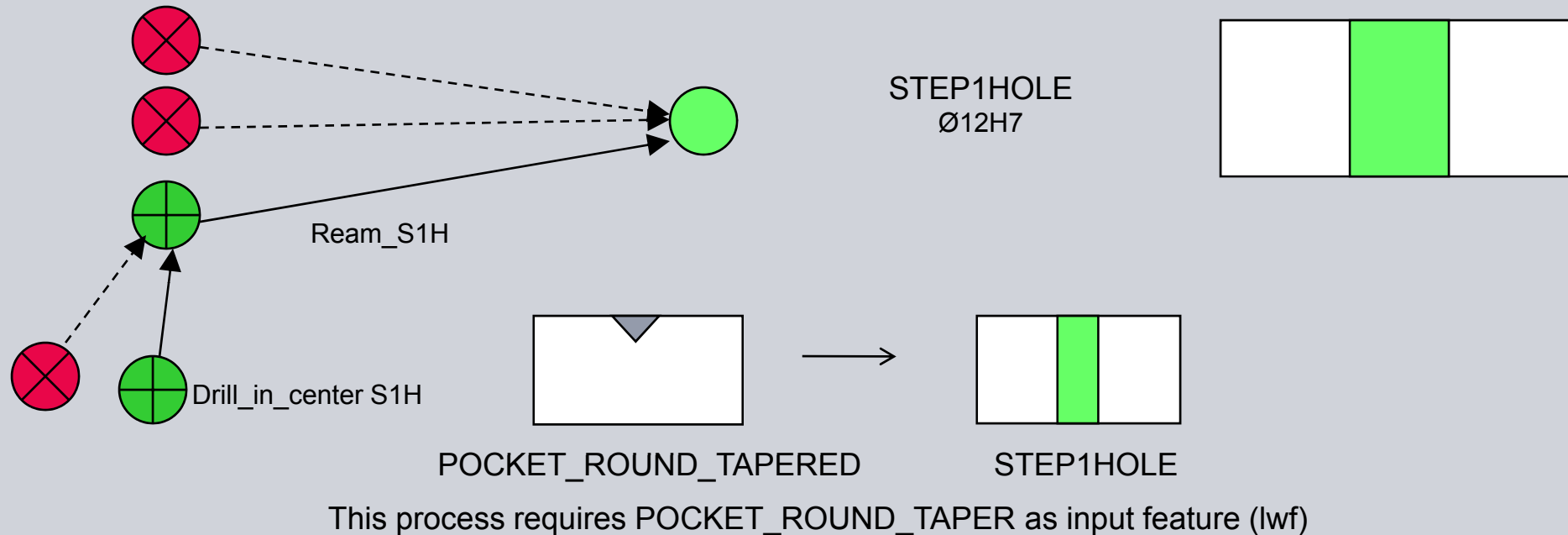
name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
(All)	(All)	(All)	(All)	STEP1HOLE	(All)
Gun_Drill_S1H	10	DRILL	1 STEP1POCKET	1 STEP1HOLE	1 GUN_DRILL
Bore_S1H	20	BORING	1 STEP1HOLE	1 STEP1HOLE	1 BORE
Ream_S1H	30	REAM	1 STEP1HOLE	1 STEP1HOLE	1 TAPER_REAMER
Chamfer_S1H_Mill	50	PLANAR_PROFILE	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Chamfer_S1H_Drill	60	SPOT_DRILLING	1 STEP1HOLE	1 STEP1HOLE	1 COUNTER_SINKING
Drill-up_S1H (optional)	80	DRILL	1 STEP1HOLE	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center_chamfer_S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill-in-center_S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill_S1H	100	DRILL	1 BLANK	1 STEP1HOLE	1 TWIST_DRILL



...Keep climbing up the priority ladder

How does the Operation Selection work?

Example



Drill_in_center_S1H would be a valid candidate to produce a STEP1HOLE.

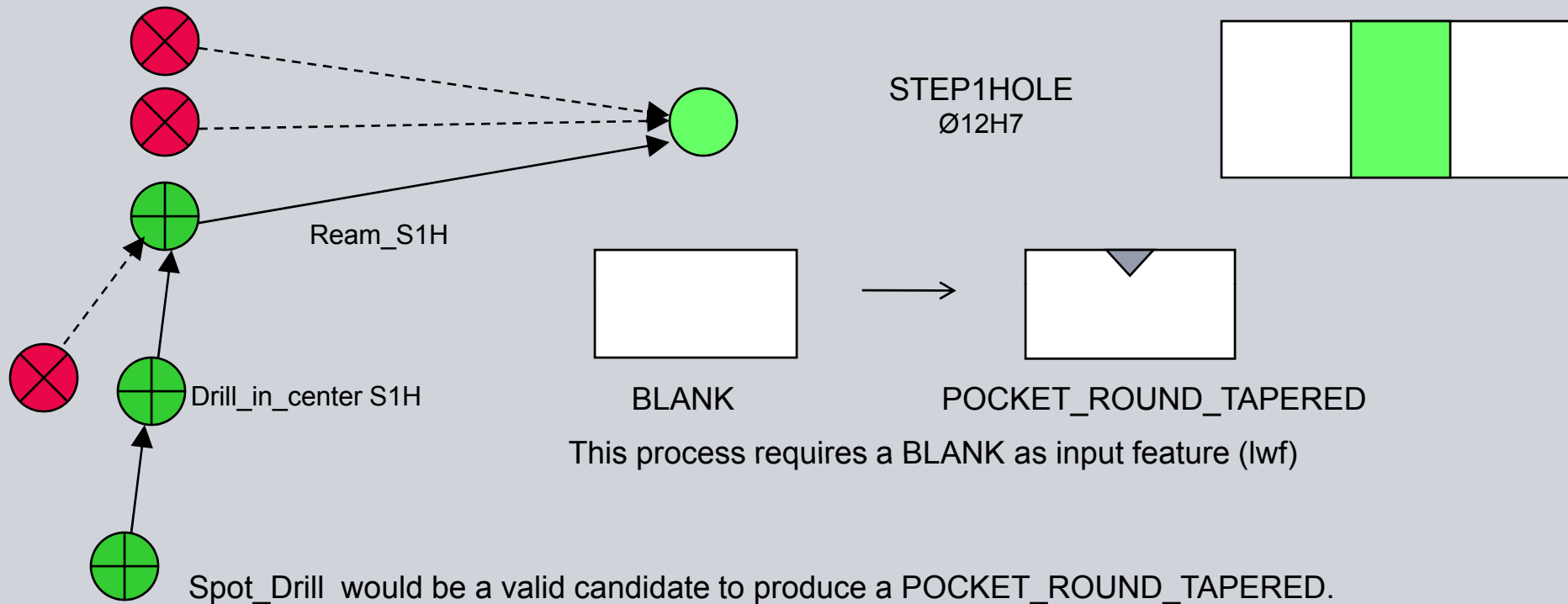
name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources
Drill-in-center_S1H	90	DRILL	1 POCKET_ROUND_TAPERED	1 STEP1HOLE	1 TWIST_DRILL
Drill_S1H	100	DRILL	1 BLANK	1 STEP1HOLE	1 TWIST_DRILL



Since the previous Ream_S1H operation requires a STEP1HOLE to be resolved, the engine is now again trying to find the best suitable process to machine a STEP1HOLE.

How does the Operation Selection work?

Example



Spot_Drill would be a valid candidate to produce a POCKET_ROUND_TAPERED.

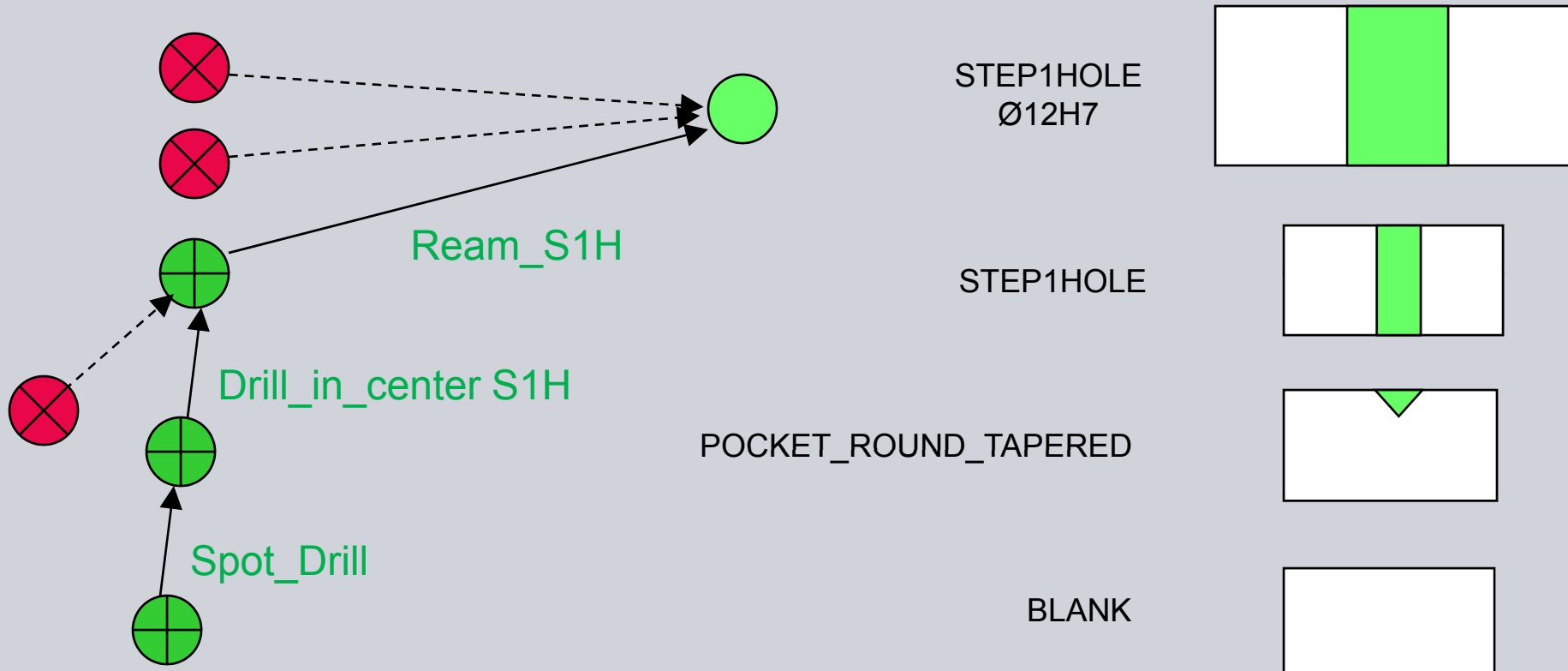
name	Priority	OperationClas	InputFeatures	OutputFeatures	Resources
(All)	(All)	(All)	(All)	(All)	(All)
Spot_Drill	1	SPOT_DRILLIN	1 BLANK	1 POCKET_ROUND_TAPERED	1 SPOT_DRILL
Spot_Drill_in_0		DRILLING	1 STEP1POCKET	1 POCKET_ROUND_TAPERED	1 SPOT_DRILL



In order to complete the process, the engine is now again trying to find the best suitable process to machine the POCKET_ROUND_TAPERED which is requested to be resolved by the previous drilling operation.

How does the Operation Selection work?

Example



The engine has successfully found a suitable set of rules to completely machine this feature
The resulting process (in this simplified example): → Spot_Drill => Drill => Ream
It will now create the operations in the Operation Navigator

How does the Operation Selection work?

Advanced Concepts

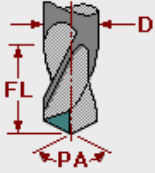
Single process selection

- Ranges
 - $6 \leq \text{Tool Diameter} < 12$
 - $\text{Tool Length} > 30$

Tool selection is optimized for all features in a run

- Consolidate tools across operations
 - Operation 1: Diameter 6-12
 - Operation 2: Diameter 10-14
 - Use Tool with Diameter = 12 for both operations

Automatic generation of Tool Queries based on tool conditions from Machining Knowledge Editor



Units
☐ Inches ☒ Millimeters

Variable Type Database Attributes ▼

Diameter
FluteLength
Holder
Material
PointAngle
libref

> >= < <= ==
!= SE SNE AND OR

Query

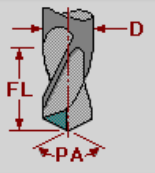
```
{DB(SubType) == 01} && {DB(Type) == 03} &&  
{DB(libref) != 0} && {DB(Diameter) >= 8.800000} &&  
{DB(Diameter) <= 9.200000} && {DB(FluteLength) > 20.000000}
```

Check Query Syntax
Sort Order

OK Apply Cancel

Class Description
Twist Drill

Legend



Matching Items

'Libref	'Description	'(D) Diameter	'(FL) Flute Length
ugt0301_030	Twist Drill 9 mm	9	81
ugt0301_204	Twist Drill 8.8 mm	8.8	81
ugt0301_205	Twist Drill 8.9 mm	8.9	81
ugt0301_206	Twist Drill 9.1 mm	9.1	81
ugt0301_207	Twist Drill 9.2 mm	9.2	81
ugt0301_483	Carbide Drill 8.8 mm	8.8	81
ugt0301_484	Carbide Drill 8.9 mm	8.9	81
ugt0301_485	Carbide Drill 9.0 mm	9	81
ugt0301_486	Carbide Drill 9.1 mm	9.1	81
ugt0301_487	Carbide Drill 9.2 mm	9.2	81

Enables quick selection of alternative tools

OK Back Cancel

How does the Operation Selection work?

Example log file – Optional Information Window



```
#----- Set 2 -----
#
#      Methods for features : 1 (STEP1HOLE_1)
#-----
#AF : 1 (STEP1HOLE_1)
# 2 : Chamfer_S1H_Drill [AF_1]
# [2] Condition 1 : This is a small diameter so the chamfer can be done by the centering operation.( IF mwf.DEPTH / mwf.
# 3 : Drill_S1H [AF_1]
# [3] Condition 2 : Constant has value = 1 (Use spot drilling)( bool_Use_Spot_Drill_Yes1_No0 = 0 )
# 4 : Gun_Drill_S1H [AF_1]
# [4] Condition 2 : is FALSE:( mwf.DEPTH / mwf.DIAMETER_1 >= Depth_Dia_Ratio_Limit )
# 5 : Ream_S1H [AF_1] -->> [F_12]
# 6 : Chamfer_S1P_Drill [F_12]
# [6] Condition 1 : This is a small diameter so the chamfer can be done by the centering operation.( IF mwf.DEPT
# 7 : Drill_S1H [F_12]
# [7] Condition 2 : Constant has value = 1 (Use spot drilling)( bool_Use_Spot_Drill_Yes1_No0 = 0 )
# 8 : Gun_Drill_S1H [F_12]
# [8] Condition 2 : is FALSE:( mwf.DEPTH / mwf.DIAMETER_1 >= Depth_Dia_Ratio_Limit )
# 9 : Ream_S1H [F_12]
# [9] Condition 2 : Roughness can be reached by drilling.( mwf.SIDE_ROUGHNESS_1 < Best_Roughness_Drilling )
# 10 : Bore_S1H [F_12]
# [10] Condition 2 : Diameter Tolerance can be made by drilling.( IT_class_ISO { mwf.DIAMETER_1 , mwf.DIAMETER_1
# 11 : Drill-in-center_chamfer_S1H [F_12]
# [11] Condition 3 : is FALSE:( mwf.DEPTH_TOP_CHAMFER > Small_Value )
# 12 : Drill-up_S1H (optional) [F_12]
# [12] Condition 2 : ( mwf.DIAMETER_1 > Pre_Drill_Limit )
# 13 : Drill-in-flat-part [F_12] -->> [F_14]
# 14 : Chamfer_S1P_Drill [F_14]
# [14] Condition 2 : Chamfering already applied or feature was not chamfered.( mwf.DEPTH_TOP_CHAMFER > SI
# 15 : Drill-in-center_S1P [F_14]
# [15] Condition 1 : Application condition ( mwf.Machining_Rule = "TWIST_DRILL" )
# 16 : Drill-up_S1P (optional) [F_14]
# [16] Condition 1 : Application condition ( mwf.Machining_Rule = "TWIST_DRILL" OR mwf.Machining_Rule =
# 17 : Mill_Rough_S1P_Contour [F_14] -->> [F_16]
# No tools available for following parameters ( tool type : END_MILL_INDEXABLE )
# Diameter < 10.100000
# 18 : Drill_S1P [F_14]
# [18] Condition 1 : Application condition ( mwf.Machining_Rule = "TWIST_DRILL_GUIDE" )
# 19 : Drill-in-center_S1H [F_12] -->> [F_16]
# 20 : Spot_Drill [F_16] -->> [F_18] ( blank )
```

Knowledge content supplied with NX CAM

Machining knowledge content supplied with NX

What is it?

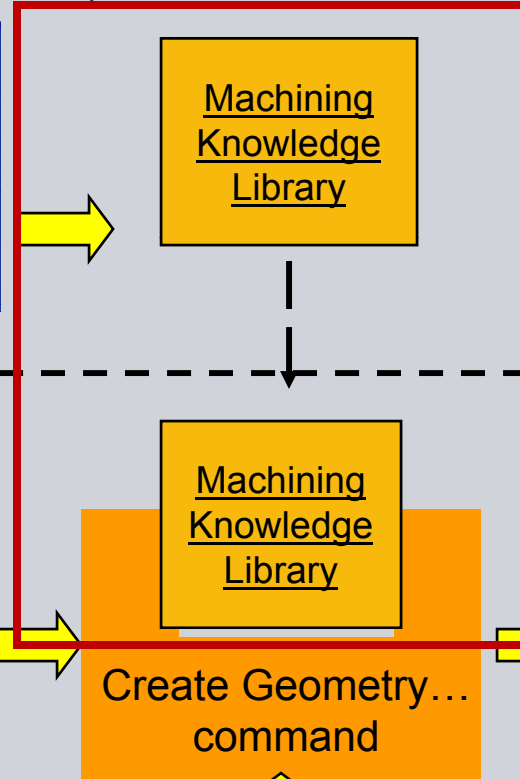
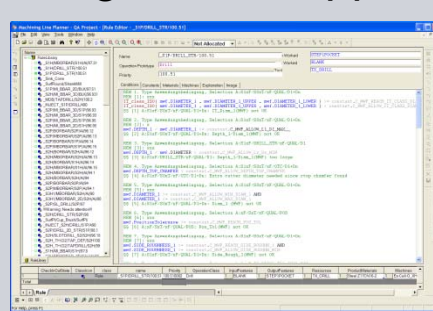
- Provides machining best practices for the NX machining feature types (holes, pockets, slots, etc.)
- Decision criteria (e.g. when to drill and when to ream) can be configured
- Content can be modified using the new Machining Knowledge Editor
- Customers can exchange methods

Benefits

- Customers can use FBM without up-front customization
- Reduces the FBM customization effort (it is much easier to modify existing content than to define content from scratch)
- Content will be maintained and updated with subsequent releases

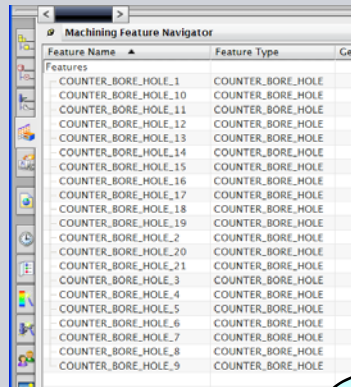
Machining Knowledge Content Concept

Subject Matter Expert; configures the best practice machining processes
(Machining Knowledge Editor application)



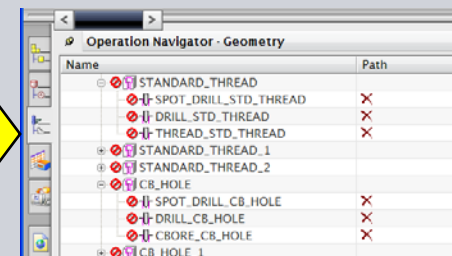
NX CAM loads the appropriate Machining Knowledge Library

NC Programmer
(NX CAM)



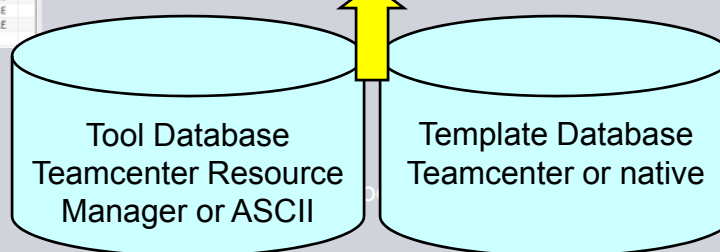
Feature Name	Feature Type
COUNTER_BORE_HOLE_1	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_10	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_11	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_12	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_13	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_14	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_15	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_16	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_17	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_18	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_19	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_2	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_20	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_21	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_3	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_4	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_5	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_6	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_7	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_8	COUNTER_BORE_HOLE
COUNTER_BORE_HOLE_9	COUNTER_BORE_HOLE

Features

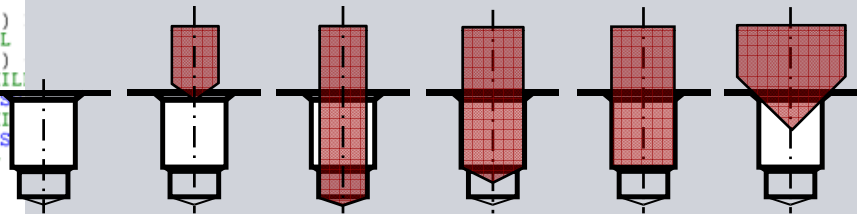
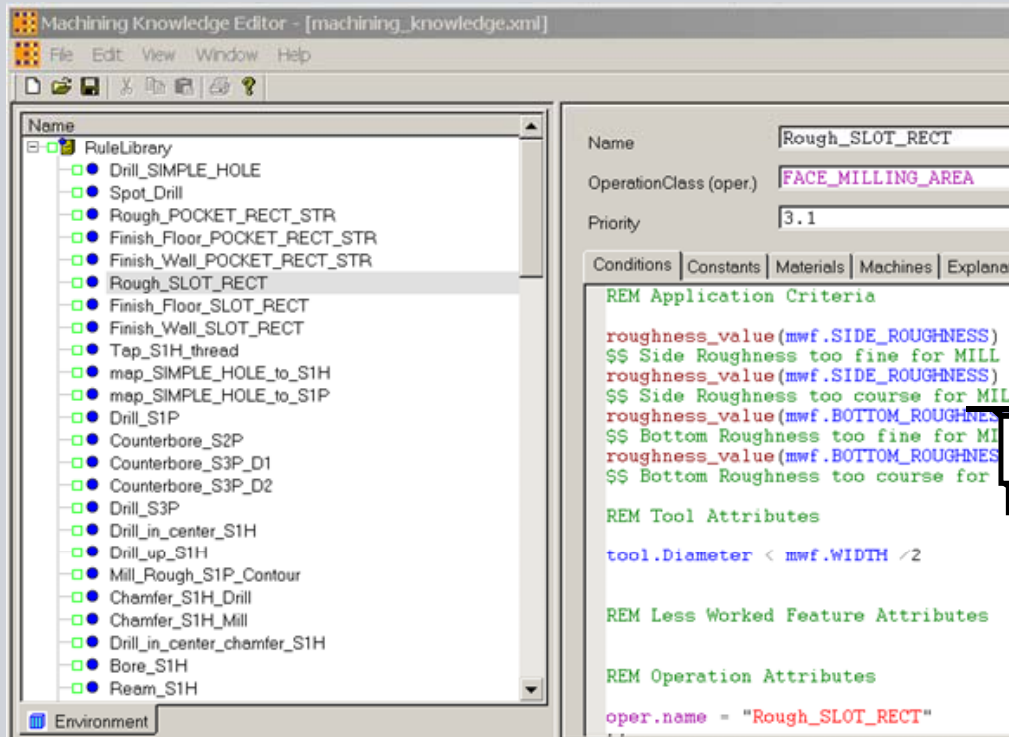


Name	Path
STANDARD_THREAD	
SPOT_DRILL_STD_THREAD	
DRILL_STD_THREAD	
THREAD_STD_THREAD	
STANDARD_THREAD_1	
STANDARD_THREAD_2	
CB_HOLE	
SPOT_DRILL_CB_HOLE	
DRILL_CB_HOLE	
CBORE_CB_HOLE	
CB_HOLE_1	

Operations



Machining knowledge content supplied with NX



Content is defined in:

UGII_CAM_MACHINING_KNOWLEDGE_DIR\machining_knowledge.xml

Edit with Machining Knowledge Editor application

Current status of Content Implementation (1/3)

The screenshot displays the 'Machining Knowledge Editor' window. On the left, a tree view shows a library of rules, with 'Rough_POCKET_RECT_STR' selected. The main area shows the configuration for this rule:

- Name:** Rough_POCKET_RECT_STR
- OperationClass (oper.):** FACE_MILLING_AREA
- Priority:** 3.1
- OutputFeatures (mwf.):** POCKET_RECTANGULAR_STRAIGHT
- InputFeatures (lwf.):** BLANK
- Resources (tool):** END_MILL_NON_INDEXABLE

The 'Conditions' tab is active, showing the following logic:

```

REM Application Criteria
roughness_value(mwf.SIDE_ROUGHNESS) >= constant.Reachable_Roughness_MILL_rough
roughness_value(mwf.BOTTOM_ROUGHNESS) >= constant.Reachable_Roughness_MILL_rough
$$ Feature needs a finishing operation.

REM Tool Attributes
tool.FluteLength >= mwf.DEPTH

REM allow bigger tool for roughing. This is just an example.
IF is_defined(mwf.Stock_Wall) THEN tool.Diameter < mwf.RADIUS*2*2 ELSE tool.Diameter < mwf.RADIUS*2
REM another upper limit for the tool.
tool.Diameter < mwf.WIDTH*0.75

REM Less Worked Feature Attributes

REM Operation Attributes

REM Tool Axis - Axis
oper.Tool_Axis_Type = "Specify_Vector"

oper.Blank_Distance = mwf.DEPTH

REM Path Settings - Cut Pattern
oper.Region_Cut_Method = "Follow_Part"
REM Path Settings - Cutting Parameters - Strategy - Cutting
oper.Cut_Walls_Only = "off"
REM Path Settings - Cutting Parameters - Strategy - Finish P
oper.Finish_Passes = 0
REM Path Settings - Cutting Parameters - Strategy - Stock
oper.Wall_Stock = mwf.Stock_Wall
oper.Stock_Floor = mwf.Stock_Floor
REM Path Settings - Cutting Parameters - Corners - Path Shap
oper.Path_Settings_Corners_Method = "Follow_Part"
REM Path Settings - Cutting Parameters - Connections - Across
oper.Across_Voids_Method = "Cut"
    
```

At the bottom, a table lists the rules in the library:

ClassIcon	class	name	Priority	OperationClass	InputFeatures	OutputFeatures	Resources	ProductMaterials
	Rule	Drill_SIMPLE_H 4.1		DRILLING	1 POCKET_R	1 SIMPLE_HOL	1 TWIST_	
	Rule	Spot_Drill 1		SPOT_DRILLING	1 BLANK	1 POCKET_RO	1 SPOT_D	
	Rule	Rough_POCKET_RECT_STR 3.1		FACE_MILLING_AR	1 BLANK	1 POCKET_RE	1 END_MI	
	Rule	Finish_Floor_PO 3.02		FACE_MILLING_AR	1 POCKET_R	1 POCKET_RE	1 END_MI	
	Rule	Finish_Wall_PO 3.01		FACE_MILLING_AR	1 POCKET_R	1 POCKET_RE	1 END_MI	
	Rule	Rough_SLOT_RECT_2 3.1		CAVITY_MILL	1 BLANK	1 SLOT_RECTA	1 END_MI	
	Rule	Finish_Floor_SLOT_RECT_2 3.02		CAVITY_MILL	1 SLOT_RECT	1 SLOT_RECTA	1 END_MI	
	Rule	Finish_Wall_SLOT_RECT_2 3.01		CAVITY_MILL	1 SLOT_RECT	1 SLOT_RECTA	1 END_MI	
	Rule	Rough_SLOT_RECT_1 3.1		FACE_MILLING_AR	1 BLANK	1 SLOT_RECTA	1 END_MI	

~150 unique operation rules defined for
STEP1-3HOLE/POCKET
STEP1-3HOLE/POCKET_THREAD
POCKETS, CORNER NOTCH, etc.

Current status of Content Implementation (2/3)

Conditions	Constants	Materials	Machines	Explanation
name	default	type		
bool_Always_Chamfer_Fe...	0	integer		
bool_Check_PointAngle_T...	0	integer		
bool_Use_Spot_Drill_Yes...	1	integer		
Center_Chamfer_Limit	12	double		
Depth_Dia_Ratio_Limit	6	double		
geo_Angle_Top_Chamfer	45	double		
geo_Depth_Top_Chamfer	1	double		
LWF_Allowance_Boring	1	double		
LWF_Allowance_Mill_Finis...	1	double		
LWF_Allowance_Mill_Finis...	1	double		
LWF_Allowance_Reaming	1	double		
LWF_DEPTH_LO	-0.02	double		
LWF_DEPTH_UP	0.02	double		
LWF_DIAM_LO	-0.2	double		
LWF_DIAM_UP	0.2	double		
PointAngle_TwistDrill	118	double		
Pre_Drill_Limit	12	double		
Reachable_IT_Class_BO...	6	integer		
Reachable_IT_Class_BO...	10	integer		
Reachable_IT_Class_DRI...	11	integer		
Reachable_IT_Class_DRI...	16	integer		
Reachable_IT_Class_MIL...	9	integer		
Reachable_IT_Class_MIL...	16	integer		
Reachable_IT_Class_RE...	5	integer		
Reachable_IT_Class_RE...	10	integer		
Reachable_Roughness_B...	0.8	double		
Reachable_Roughness_B...	12.5	double		

Behavior can easily be configured using global CONSTANTS:

- BOOL_Always_Chamfer_Features (Y/N)
- BOOL_Check_PointAngle_Twist_Drill (Y/N)
- etc.

Change threshold values as a 1st level of customization

- Pre_Drill_Limit (12)
- BEST_IT_Class_Drilling (6)
- BEST_IT_Class_Milling (10)
- etc.

Current status of Content Implementation (3/3)

Basis for content:

- JAD partner input (best practice)
- Threshold values based on IT (International Tolerance System)

OperSequencesJAD.xls [Compatibility Mode] - Microsoft Excel

Home Insert Page Layout Formulas Data Review View

Clipboard Font Alignment Number

Conditional Formatting Table Styles

Conditions Constants Materials Machines Explanation

name	default
LWF_DEPTH_LO	-0.02
LWF_DEPTH_UP	0.02
LWF_DIAM_LO	-0.2
LWF_DIAM_UP	0.2
PointAngle_TwistDrill	118
Pre_Drill_Limit	12
Reachable_IT_Class_BORE_Lower	6
Reachable_IT_Class_BORE_Upper	10
Reachable_IT_Class_DRILL_Lower	11

E33

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		IT 4	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16
2	Ra = 0,4	R	R	R	R	M-R	M-R	M	M	M	M	M	M	M
3	Ra = 0,8	R	B-R	B-R	B-R	M-B-R	D-M-B-R	D	D	D	D	D	D	D
4	Ra = 1,6	R	B-R	B-R	B-R	M-B-R	D-M-B-R	D	D	D	D	D	D	D
5	Ra = 3,2	R	B-R	B-R	B-R	M-B-R	D-M-B-R	D	D	D	D	D	D	D
6	Ra = 6,3		B	B	B	M-B	D-M-B	D	D	D	D	D	D	D
7	Ra = 12,5		B	B	B	M-B	D-M-B	D	D	D	D	D	D	D
8	Ra = 25					M	M	M	M	M	M	M	M	M
9														
10	Legend													
11	D = DRILL													
12	M = MILL													
13	B = BORE													
14	R = REAM													
15														
16	Table 1: Operation (Tool) selection in order of priority for combinations of IT grade and Surface Roughness													
17	Reachable_Roughness_MILL_Upper	25												
18	Reachable_Roughness_MILL_Upper_...	Ra 25 microm...												
19	Reachable_Roughness_REAM_Lower	0.4												
20	Reachable_Roughness_REAM_Upper	3.2												

OOTB Default Treshold Values Consolidated Treshold Table

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Additional NX 6 FBM enhancements

What is it?

- Enhancements to Machining Feature Navigator filters
 - Safe filter in part file or in registry / indicate what filter is applied
 - Define filter on common attributes across multiple feature types
 - Filter editing
 - Additionally apply MCS filter to list only features that are parallel to the tool axis defined in the MCS
- Change propagation (indicate feature changes)
- Safe clearance in hole making
- Tool path status/indication in the Operation Navigator

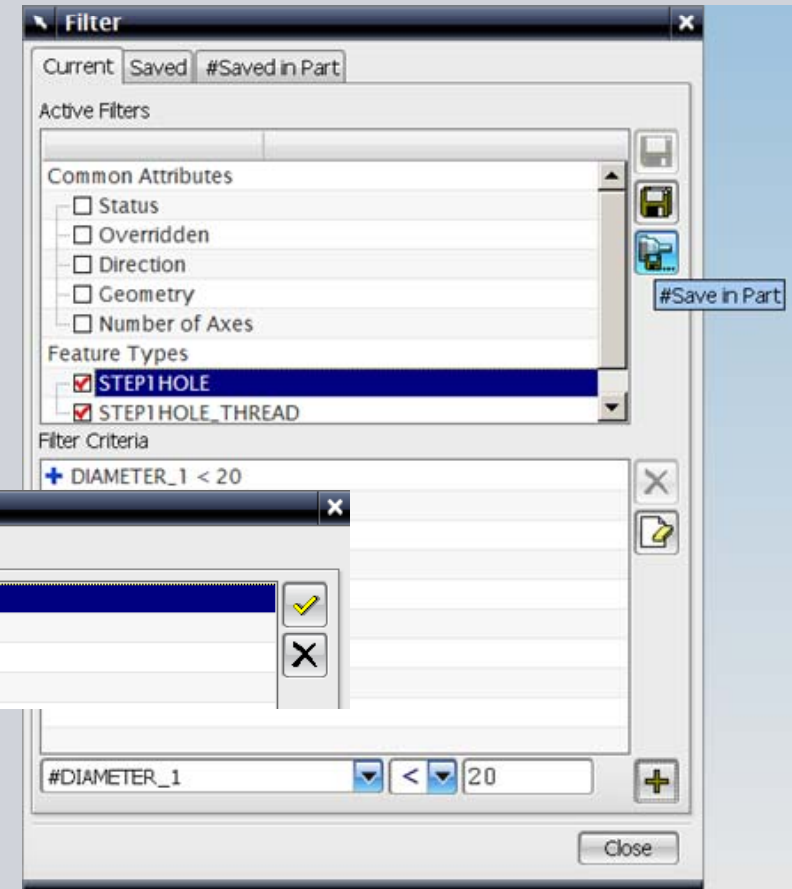
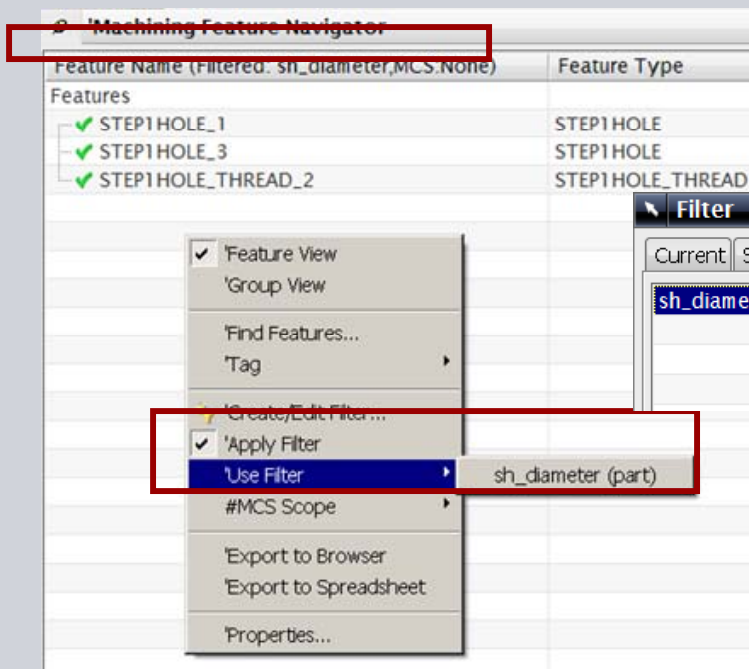
Benefits

- Faster, improved feature handling
- Immediate feedback when features have changed
- Secure tool path

Additional FBM enhancements

Feature Navigator Filter Enhancements

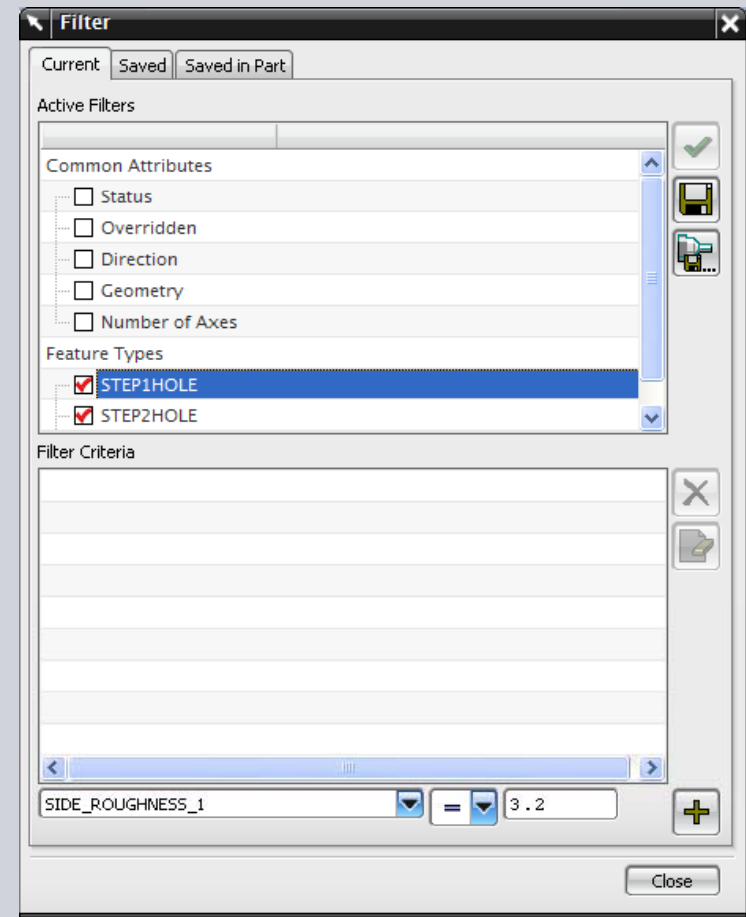
- Safe filter in part file (new) or in registry (existing) and indicate current filter
 - Retain filters in part file
 - Define part specific filters for reuse
 - Makes it easier for users to share filters
 - Indicates what filter is currently in use



Additional FBM enhancements

Feature Navigator Filter Enhancements

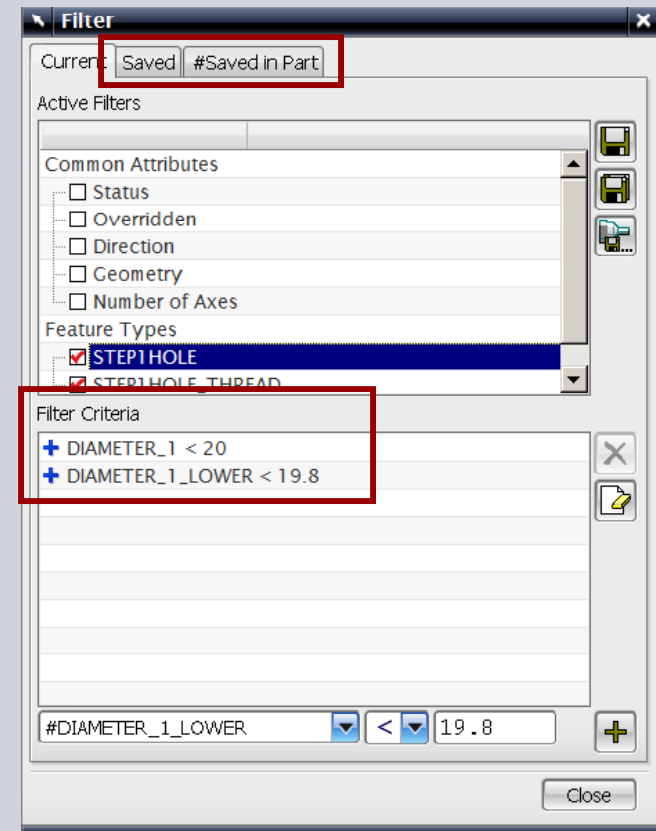
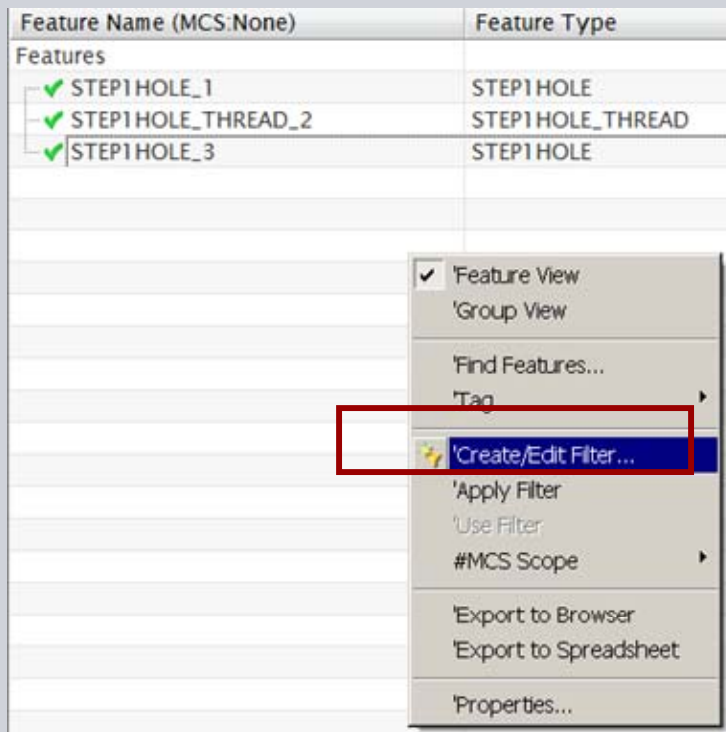
- Define filter for common attributes across multiple feature types
 - Select multiple feature types and use common attributes for criteria definition
 - Reduce the amount of filters (i.e. want to define filter for features of various types that have a common tolerance parameter)



Additional FBM enhancements

Feature Navigator Filter Enhancements

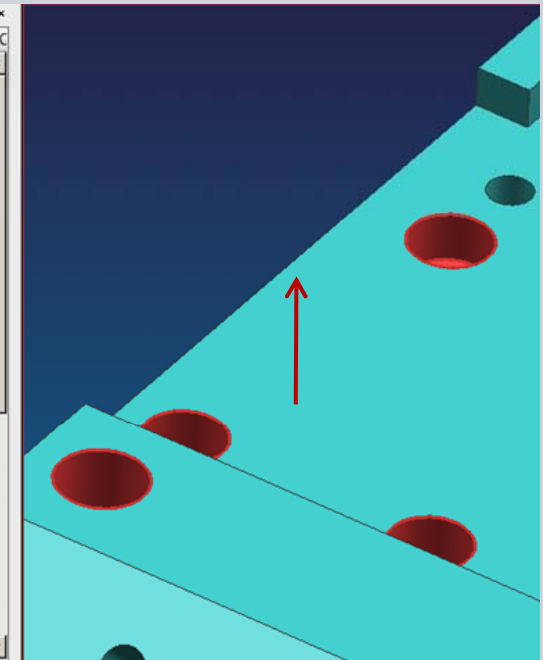
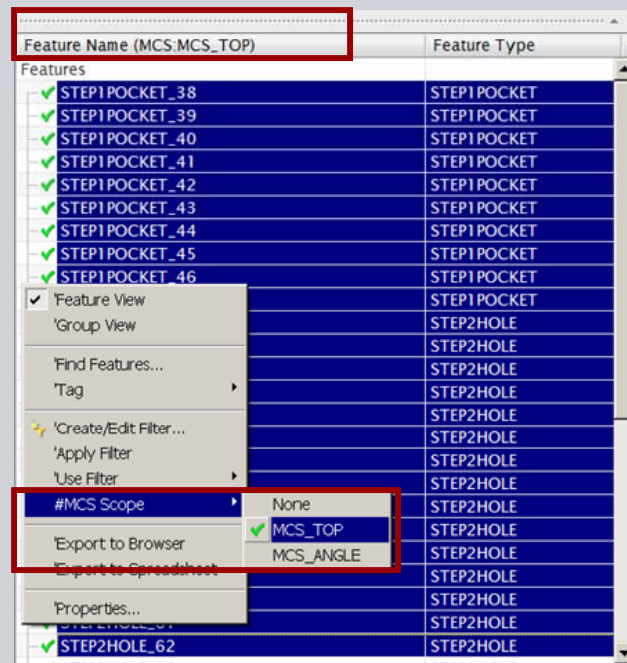
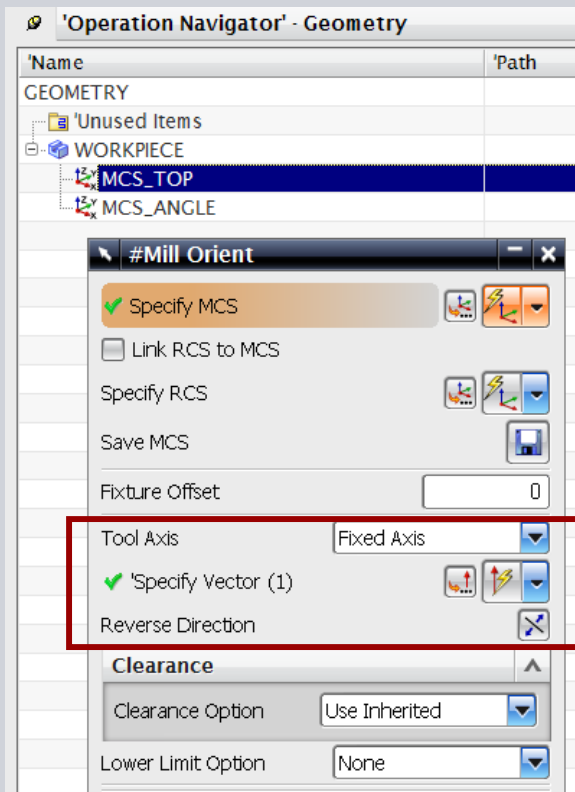
- Filter editing
 - Change filter content in saved filters instead of deleting/creating new filters
 - Add / remove criteria



Additional FBM enhancements

Feature Navigator Filter Enhancements

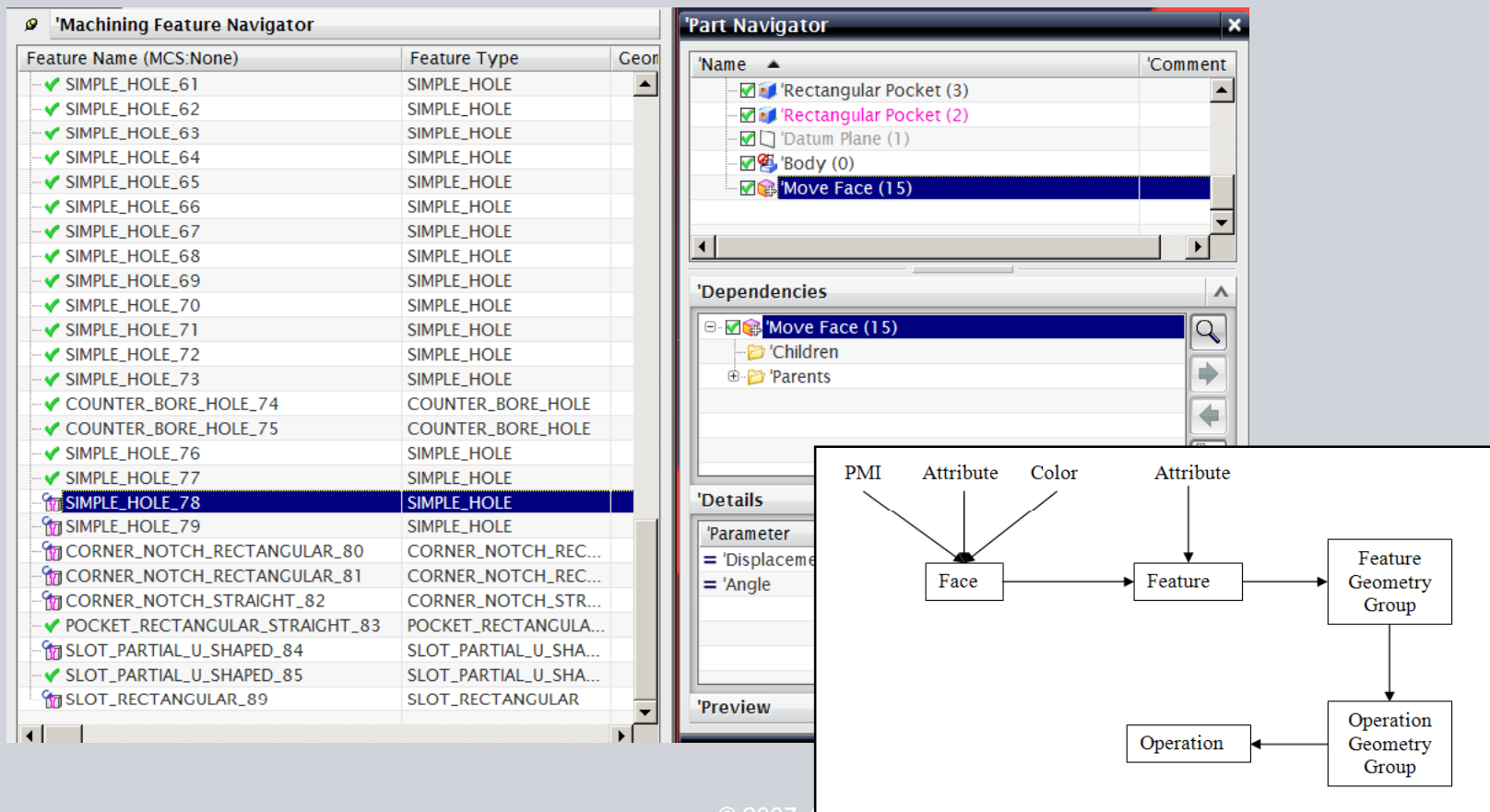
- Apply permanent MCS filter to list only features that are aligned to the tool-axis definition of the MCS
- Improves feature handling for multi-side programming



Additional FBM enhancements

Feature Change Propagation (1/3)

- Change propagation (indicate feature changes)

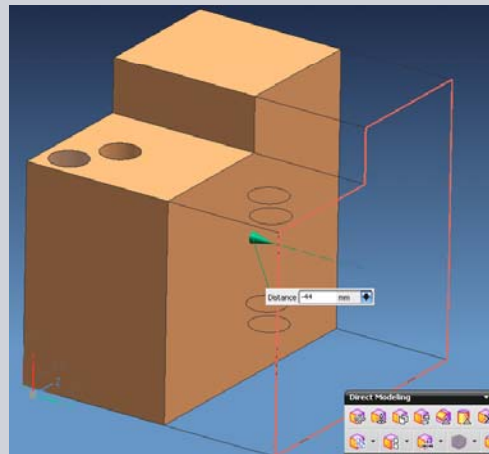
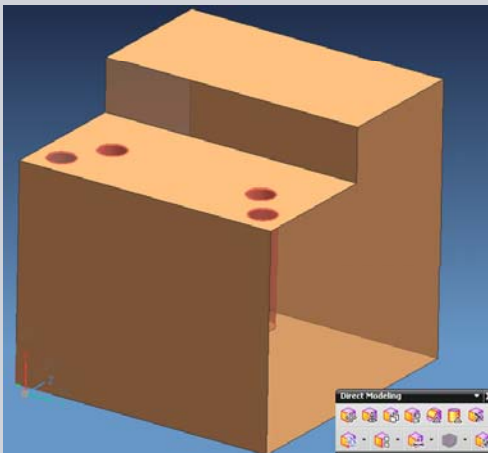


Additional FBM enhancements

Feature Change Propagation (2/3)

- Change propagation (indicate feature changes)
 - Automatically re-runs the recognition to update feature data
 - Indicate changes in Feature Navigator immediately after design change
 - Current support for geometry and attribute change
 - Indication of non geometrical changes (i.e. PMI) is planned
 - Indicates change status with individual icon in front of the feature name
 - ✓ Feature is up-to-date (initial situation)
 - ✗ Feature is changed-and-updated
 - ✗ Feature is invalid (user should remove it)

Pull Face



UPDATED Features

Features	
✗	STEP1POCKET_1
✓	STEP1POCKET_2
✗	STEP1POCKET_3
✓	STEP1POCKET_4

Additional FBM enhancements

Feature Change Propagation (3/3)

- Change propagation (indicate feature changes)
 - MB3 → Approve Change command will reset the status to up-to-date (✅)

'Machining Feature Navigator'

Feature Name (MCS:None)	Feature Type
Features	
✅ COUNTER_BORE_HOLE_75	COUNTER_BORE_HOLE
✅ SIMPLE_HOLE_76	SIMPLE_HOLE
✅ SIMPLE_HOLE_77	SIMPLE_HOLE
❌ SIMPLE_HOLE_78	SIMPLE_HOLE
❌ SIMPLE_HOLE_79	SIMPLE_HOLE
❌ CORNER_NOTCH_RECTANGULAR_80	CORNER_NOTCH_REC...
❌ CORNER_NOTCH_RECTANGULAR_81	CORNER_NOTCH_REC...
❌ CORNER_NOTCH_STRAIGHT_82	CORNER_NOTCH_STR...
✅ POCKET_RECTANGULAR_STRAIGHT_83	POCKET_RECTANGULA...
❌ SLOT_PARTIAL_U_SHAPED_84	SLOT_PARTIAL_U_SHA...
✅ SLOT_PARTIAL_U_SHAPED_85	SLOT_PARTIAL_U_SHA...
❌ SLOT_RECTANGULAR_89	SLOT_RECTANGULAR

Approve Changes

Tag Features...

Create Geometry...

Delete

Export Feature Information

'Machining Feature Navigator'

Feature Name (MCS:None)	Feature Type
Features	
✅ COUNTER_BORE_HOLE_75	COUNTER_BORE_HOLE
✅ SIMPLE_HOLE_76	SIMPLE_HOLE
✅ SIMPLE_HOLE_77	SIMPLE_HOLE
❌ SIMPLE_HOLE_78	SIMPLE_HOLE
❌ SIMPLE_HOLE_79	SIMPLE_HOLE
❌ CORNER_NOTCH_RECTANGULAR_80	CORNER_NOTCH_REC...
❌ CORNER_NOTCH_RECTANGULAR_81	CORNER_NOTCH_REC...
❌ CORNER_NOTCH_STRAIGHT_82	CORNER_NOTCH_STR...
✅ POCKET_RECTANGULAR_STRAIGHT_83	POCKET_RECTANGULA...
❌ SLOT_PARTIAL_U_SHAPED_84	SLOT_PARTIAL_U_SHA...
✅ SLOT_PARTIAL_U_SHAPED_85	SLOT_PARTIAL_U_SHA...
✅ SLOT_RECTANGULAR_89	SLOT_RECTANGULAR

Additional FBM enhancements

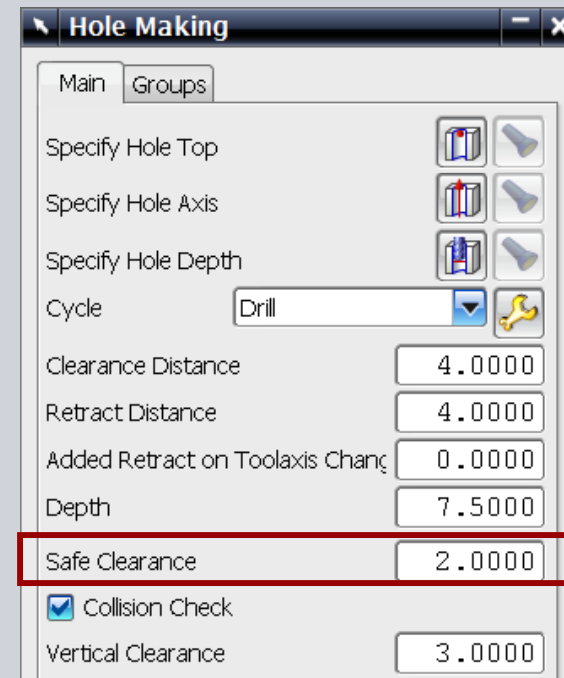
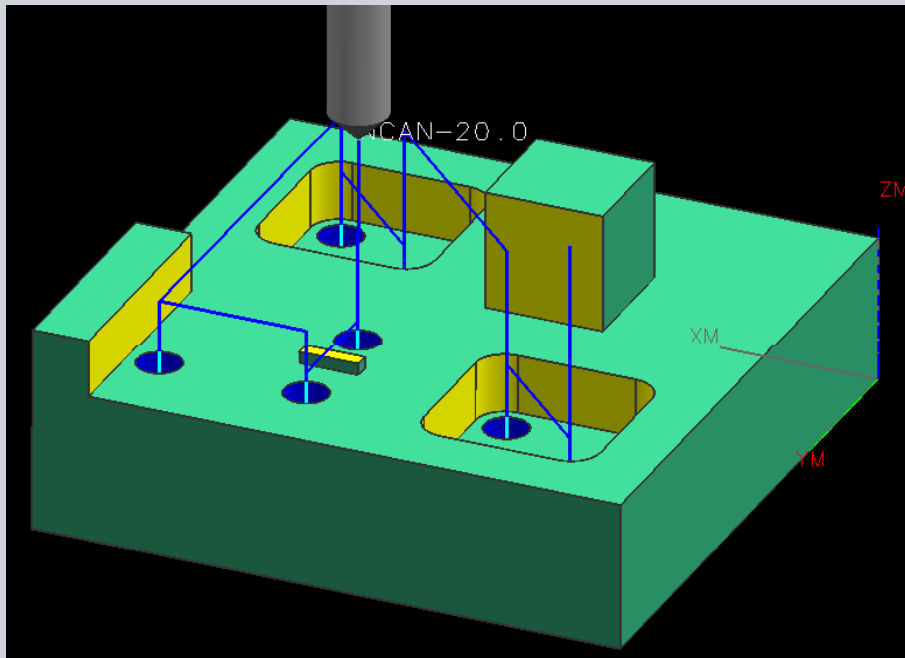
Safe Clearance parameter in Hole making

What is it?

- Safe Clearance parameter in hole making

Benefits

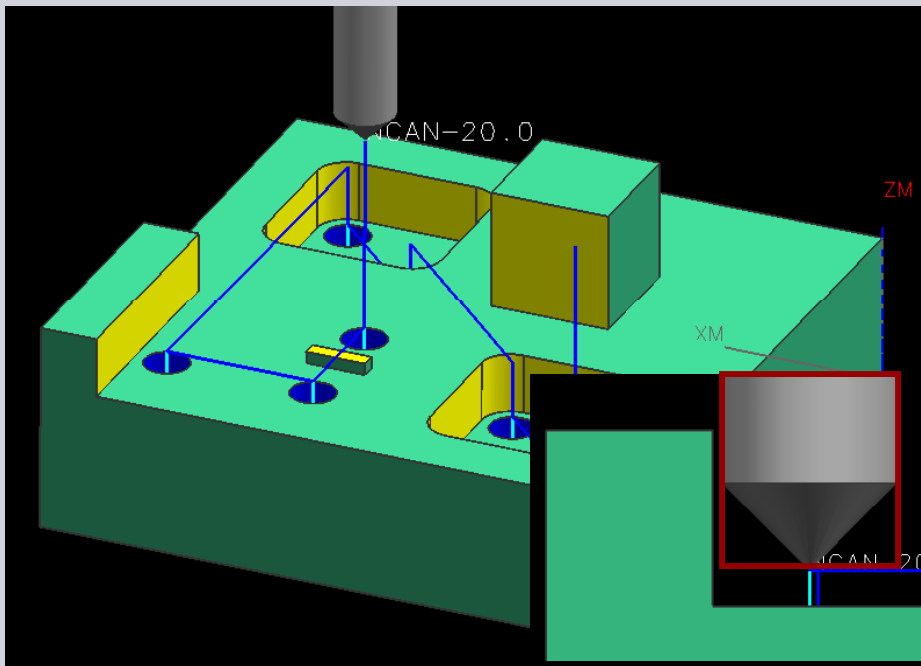
- Avoid collision with a part, such as excess material on a casting, that is not represented by the solid model



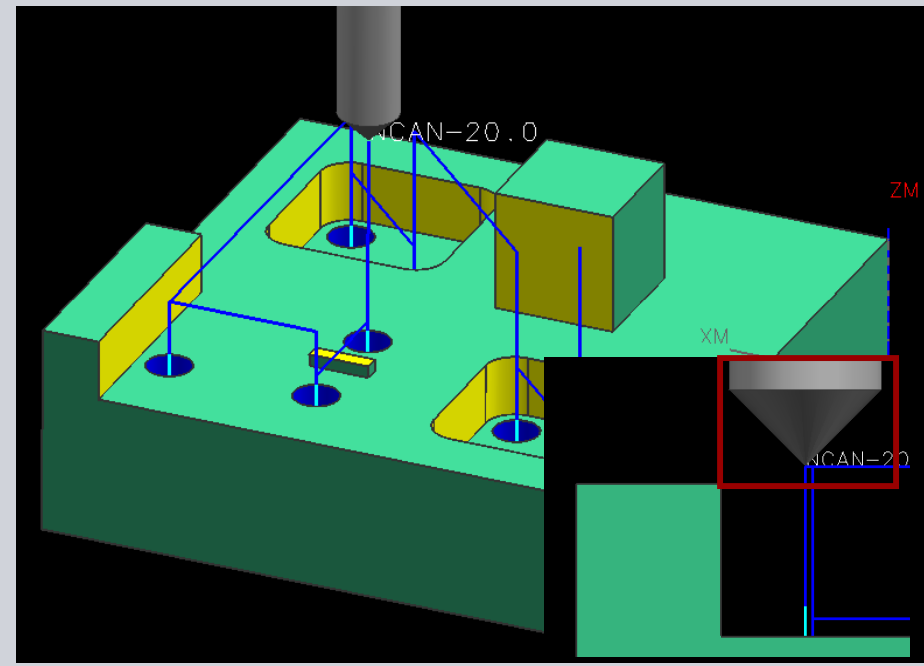
Additional FBM enhancements

Safe Clearance Parameter in Hole making

- Clearance zone is applied to all horizontal transition moves
- Avoid collisions or near collisions when transitioning between holes
- Retracts to Vertical Clearance before transition if zone violates the part



No Safe Clearance → Direct Transition



Safe Clearance → Retract to “Safe Level”
before horizontal transition

Additional FBM enhancements

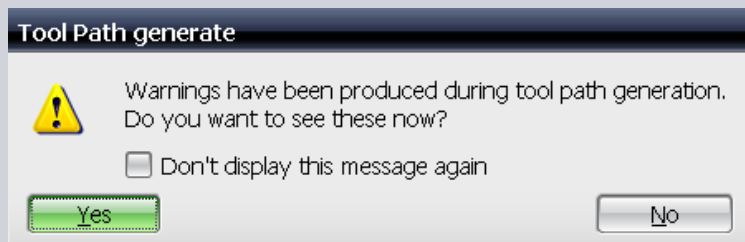
Tool Path Generation

What is it?

- Avoid tool path generation if a previous operation has failed to generate the feature (i.e. due to collision check)
- Indicate in the Operation Navigator that the tool path was not generated (is empty) because a previous operation has failed to machine the feature

Benefits

- Avoid postprocessing invalid tool path



'Operation Navigator' - Program Order		
'Name'	'Toolchange'	'Path'
NC_PROGRAM		
'Unused Items'		
! PROGRAM		
! SPOT_DRILL		
! OPTIMIZED_NC		
! SPOT_DRILL_SIMPLE_HOLE_1		X
! SPOT_DRILL_SIMPLE_HOLE_3		X
! SPOT_DRILL_SIMPLE_HOLE_5		X
! SPOT_DRILL_SIMPLE_HOLE_7		X
! DRILL		
! DRILL_SIMPLE_HOLE_1		✓
! DRILL_SIMPLE_HOLE_3		
! DRILL_SIMPLE_HOLE_5		✓
! DRILL_SIMPLE_HOLE_7		✓

```
----- Diagnostic Information -----  
#----- Object name: DRILL_SIMPLE_HOLE_3 -----  
One or more features were not generated because a previous operation failed to generate these features
```

Additional FBM enhancements

Tool Path Status indication in Operation Navigator

What is it?

- Indicate Suspect or Empty tool path in the Operation Navigator if the operation fails to generate the tool path for one or more features

Benefits

- See what operation failed to generate so that you can take action

The screenshot shows the 'Operation Navigator' - Program Order window. The tree view on the left includes 'NC_PROGRAM', 'Unused Items', 'PROGRAM', and 'SPOT_DRILL'. The 'SPOT_DRILL' operation is expanded, showing a list of features: 'SPOT_DRILL_SIMPLE_HOLE_1', 'SPOT_DRILL_SIMPLE_HOLE_3', 'SPOT_DRILL_SIMPLE_HOLE_5', and 'SPOT_DRILL_SIMPLE_HOLE_7'. The 'Toolchange' column shows a tool change icon for the first feature, and the 'Path' column shows a green checkmark. A tooltip 'Empty Tool Path' is visible over the 'Path' column.

Name	Toolchange	Path
NC_PROGRAM		
Unused Items		
PROGRAM		
SPOT_DRILL		
SPOT_DRILL_SIMPLE_HOLE_1	⚙️	✓
SPOT_DRILL_SIMPLE_HOLE_3		□
SPOT_DRILL_SIMPLE_HOLE_5		
SPOT_DRILL_SIMPLE_HOLE_7		✓

The screenshot shows the 'Operation Navigator' - Program Order window. The tree view on the left includes 'NC_PROGRAM', 'Unused Items', 'PROGRAM', and 'SPOT_DRILL'. The 'SPOT_DRILL' operation is expanded, showing a list of features: 'SPOT_DRILL_SIMPLE_HOLE_1', 'SPOT_DRILL_SIMPLE_HOLE_3', 'SPOT_DRILL_SIMPLE_HOLE_5', and 'SPOT_DRILL_SIMPLE_HOLE_7'. The 'Toolchange' column shows a tool change icon for the first feature, and the 'Path' column shows a red 'X' and a tooltip 'Suspect'.

Name	Toolchange	Path
NC_PROGRAM		
Unused Items		
PROGRAM		
SPOT_DRILL		
OPTIMIZED_NC		⚙️
SPOT_DRILL_SIMPLE_HOLE_1	⚙️	✗ Suspect
SPOT_DRILL_SIMPLE_HOLE_3		✗
SPOT_DRILL_SIMPLE_HOLE_5		✗
SPOT_DRILL_SIMPLE_HOLE_7		✗

Additional FBM enhancements

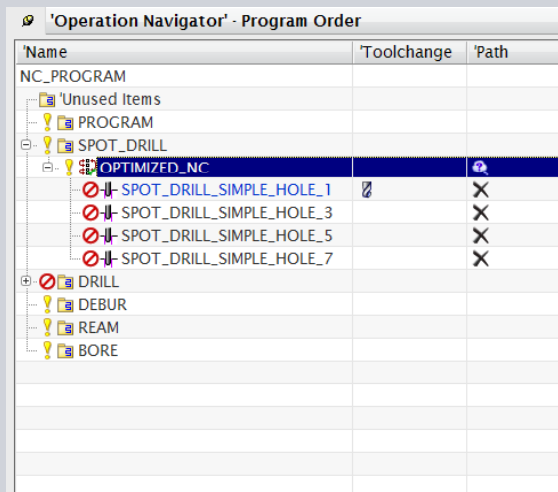
Highlight Features and Tool Path

What is it?

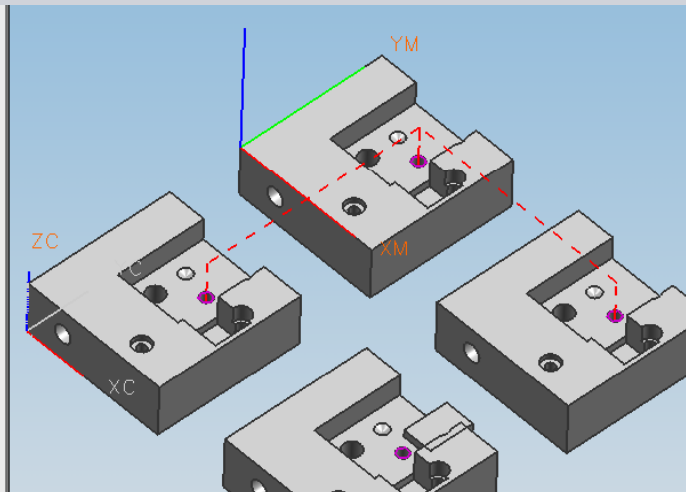
- Highlighting features and tool path when selecting objects in the Operation Navigator
 - Highlight features when selecting feature groups
 - Highlight features and tool path when selecting optimized groups
 - Highlight tool path when selecting operations

Benefits

- Directly see tool path results and associated features without editing the objects



Name	Toolchange	Path
NC_PROGRAM		
Unused Items		
PROGRAM		
SPOT_DRILL		
OPTIMIZED_NC		
SPOT_DRILL_SIMPLE_HOLE_1	X	X
SPOT_DRILL_SIMPLE_HOLE_3	X	X
SPOT_DRILL_SIMPLE_HOLE_5	X	X
SPOT_DRILL_SIMPLE_HOLE_7	X	X
DRILL		
DEBUR		
REAM		
BORE		



Summary

What is available with NX 6 CAM - Features



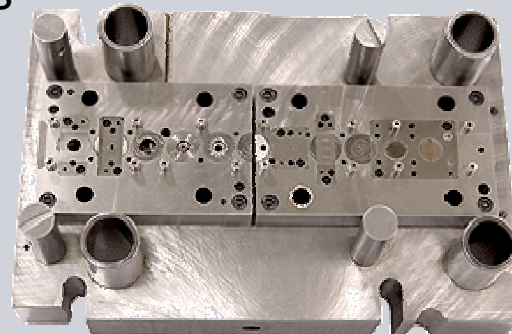
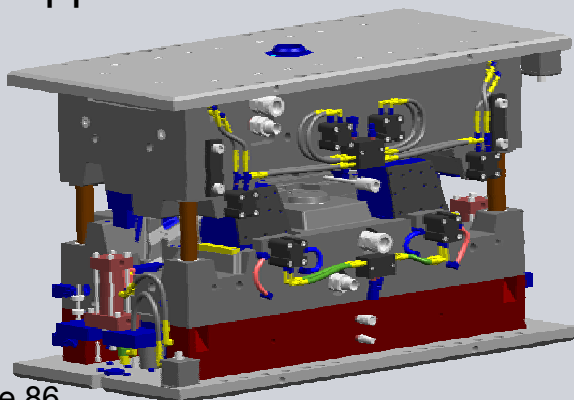
Feature & PMI Recognition

- New Feature library with **50 additional feature types**
 - Focus on prismatic machining (drilling and 2½D milling)
 - Holes, Pockets, Slots, Grooves, Notches
- Support for **PMI**
 - Dimension tolerances
 - Surface finish
 - Thread & Thread tolerances
 - Colors & Attributes



Feature Identification

- Support for NX 6 AHF features

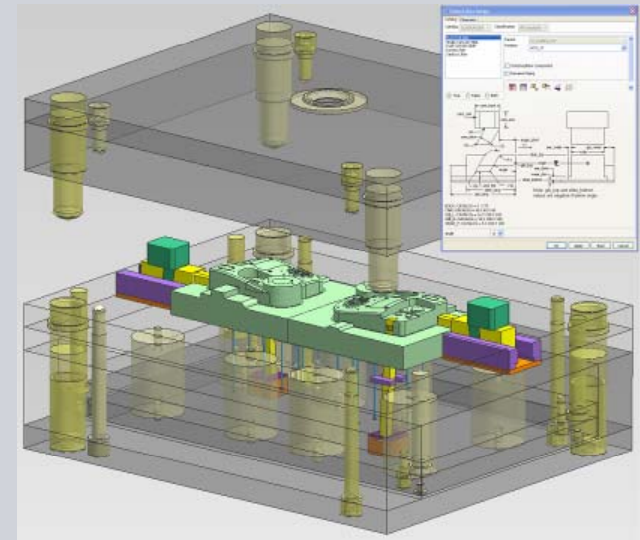
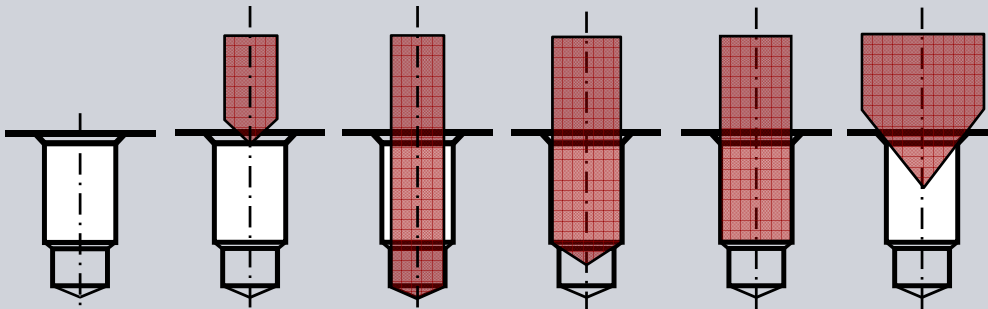


Summary

What is available with NX 6 CAM - Operations

Automatic best practice process and tool selection

- New Machining Knowledge Editor application
- Example best practice rules (~ 150) for the new feature types
 - Mold bases
 - Machinery parts



www.siemens.com/plm